U.S. BUREAU OF PLANT INDUSTRY

Handbook of the diseases of fruits occurring under market, storage and transit conditions.

U. S. Department of Agriculture,
Bureau of Plant Industry,
co-operating with
Bureau of Markets.

Handbook of the Diseases of Fruits

Occurring under Market, Storage

and Transit Conditions.

By
D. H. Rose and O. F. Burger
Pathologists, Fruit Disease Investigations.

Prepared
under the direction of
M.B.Waite, Pathologist in Charge,
Bureau of Plant Industry.

and

C.T.More, Specialist in Charge,
Food Products' Inspection Service,
Bureau of Markets.

TABLE OF CONTENTS.

Introduction. 4

Diseases.

Key to apple diseases. 14

Apple.

Alternaria rot ..... 17 a
Anthracnose 18
Bitter pit 19
Bitter rot 22
Black rot 24
Blotch 26
Blue mold rot 28
Brown core ..... 29 a
Brown rot 30
Core rot ..... 30 a
Fly speck ..... 30 b
Freezing injury 31
Fruit spot 33
Gray mold rot 34
Internal breakdown 35
Jonathan spot 36
Leaf roller injury ..... 37 a
Lesser apple worm injury 38
Apple maggot injury 40
Pink mold rot 41
Russet ..... 41 a
Rust 42
San Jose' scale ..... 42 a
Scab 43
Scald 45
Soft scald 48
Sooty blotch ..... 30 c 48 a
Spray injury 49
Stigmonose ..... 49 a
Water core 50

Apricot.

Pustular spot 52

Banana.

Anthracnose 53

Blackberry.

Blue mold rot 54

Cherry.

Brown rot 55
Rhizopus rot and blue mold rot 56

Citrus fruits - general.
Blue mold rot 57

Grapefruit.
Buckskin 59
Melanose 60
Nail head rust ..... 60 a
Pox ..... 60 b
Purple scale ..... 60 c
Scab 61
Stem-end rot 62
Tear staining 65

Lemon.
Brown rot ..... 65 a
Cottony rot ..... 65 b
Fumigation injury ..... 65 c
Green mold rot 66
Alternaria rot or center rot 67
Pit or Peteca ..... 67 a

Lime.
Scald and blue mold rot 68

Orange.
Black rot or Alternaria rot ..... 68 a
Freezing injury ..... 68 b
Stem-end rot (Diplodia) ..... 68 d
Stem-end rot (Phomopsis) 69
Thorn injury 70
Thrips injury ..... 70 a

Cranberry.
Fungous rots 71
Smothering injury 72

Gooseberry.
Mildew ..... 72 a

Grape.
Gray mold rot 73
Rhizopus rot 74

Peach.
Bacterial spot 75
Brown rot 76
Brown rot and Rhizopus rot 76
Curculio injury 79
Hail injury 80

Rhizopus 81
Scab 82

Pear and apple.
Pink mold rot 83

Pear.
Black rot ..... 84 a
Black spot ..... 84 b
Rhizopus rot ..... 84 c
Scab 85
Sooty Blotch ..... 85 a

Pineapple.
Black rot 86

Plum.
Blue mold rot 88
Brown rot and Rhizopus rot 89
Rhizopus rot 90
Russet 91

Quince.
Black spot ..... 91 a

Raspberry (black).
Rhizopus rot 92

Strawberry.
Gray mold rot 93
Rhizopus rot; leak 94
Sclerotinia rot 96

INTRODUCTION

This handbook is designed to aid inspectors of the Bureau of Markets in identifying the diseases of fruits as they occur under market, storage and transit conditions. Since the work on fruits was begun only a little more than a year ago, the book is of necessity incomplete in respect to both descriptive text and illustrations. On account of the lack of funds it has been impossible to include many pictures which otherwise would have been in the book. Certain important diseases are therefore represented only by description.

Because of the very able discussion in the vegetable disease handbook relative to plant structures and plant processes, and of the role of fungi, bacteria and external conditions in plant diseases, it is unnecessary to take up those matters again here. It is worth while, however, to call attention to certain differences between fruits and vegetables in respect to the general diseases which affect them. For fruits these diseases are, Rhizopus rot and gray mold rot, found also on vegetables, and blue mold rot, found only occasionally on vegetables. Typical watery soft rot as it occurs on vegetables has not been found on fruits, but the fungus causing it (Sclerotinia libertiana) produces a serious rot of lemons (cottony rot). What seems to be the same fungus is sometimes found on strawberries. Slimy soft rot, due to bacteria, though common on vegetables does not occur on fruits on the market. The acid content of most fruits is probably sufficient reason for the non-occurrence of this disease. There is the further fact that only a few fruits such as strawberries and dewberries regularly come in contact with the soil, a fact which may also explain why various soil fungi common on vegetables are not found attacking fruits.

CLASSIFICATION OF DISEASES.

It has been the custom to refer to the fungi causing such diseases as apple rust, citrus stem-end rot and peach scab as parasites or true parasites, and to Rhizopus, blue mold, (Penicillium)

and gray mold (Botrytis as saprophytes, in cases where these fungi cause infection at any time after the fruit leaves the field. It seems to us rather difficult to make these distinctions for all fungi causing diseases of fruits on the market. We choose, therefore, to classify diseases rather than fungi and give in the following outline our idea of how such a classification should be made. Some diseases are not caused by fungi.

I. Diseases which originate in the field.
   (a) Diseases important in the field but not able to develop or spread during the processes of marketing.
   Examples: apple rust, apple blotch, peach scab.

   (b) Diseases important in the field and able to develop and spread.
   Examples: apple scab, brown rot of stone fruits, citrus stem-end rot.

II. Diseases which originate during the processes of marketing and are intimately associated with them.
   Examples: Rhizopus rot, blue mold rot, gray mold rot, apple scald, freezing injury.

Diseases which originate in the field may or may not be important on the market depending (1) upon the amount of infection when the fruit is picked and (2) upon whether they are able to develop or spread during the processes of marketing. Peach scab and apple rust do not develop or spread after the fruit leaves the orchard and are important on the market mainly as blemishes. Citrus stem-end rot and brown rot of stone fruits develop during marketing and are of very great importance on the market. Diseases such as Rhizopus rot or blue mold rot which originate during transit or during any of the other steps in marketing are naturally of importance only on the market.

MARKET DISEASES OF APPLES.

Market inspectors who are also acquainted with field conditions are well aware of the difference between diseases in the field and those on the market. They know that apple rust and apple bitter rot for example are rarely found on the market but are of great importance in the field. They know also that blue mold rot is one of the most serious diseases of apples on the market but is usually of little importance in the field. They may not know, however, just how the various diseases show up on all markets or over a protracted period of time. For this reason there is presented below a summary of the data from inspection certificates issued on all markets for 346 carloads of apples during the period from January 1, 1918 to January 7, 1919.

Disease.	Percentage of total number of carloads showing the disease.
Decay	29.8
Scald	24.8
Freezing injury	20.7
Blue mold	10.0
Blotch	5.4
Scab	3.9
Brown rot	1.8
Physiological	1.5
Black rot	0.6
Bitter pit	0.12
Bitter rot	0.19

An examination of the above data shows that the diseases which are rarely met with in the field, scald, freezing injury and blue mold rot, are precisely those which are most important on the market. True field diseases, in the above table, are seen to be relatively unimportant on the market. The largest single item, decay, probably included diseases of both kinds but there is no way of telling, from the certificates, which they were. The number of indefinite reports of this kind however, emphasizes the need of more careful inspection and

of greater efforts by inspectors to familiarize themselves with all of the important apple diseases.

As as example of the variety of diseases that can be distinguished on the market by a pathologist there is given below a summary of the results of 1500 isolations made from specimens obtained on the Boston market.

Fungus.	Percentage showing the fungus.
Alternaria	60.32
Physalospora (black rot fungus)	12.42
Penicillium (blue mold)	8.37
Phoma (fruit spot)	2.36
Botrytis (gray mold)	0.93
8 miscellaneous fungi	6.03
Sterile cultures	10.34

Inspectors should be able to distinguish rots caused by the fungi given by name in the above list. Those caused by the fungi included under the term miscellaneous are relatively unimportant and not well enough known at present for anyone to be able to distinguish them without making cultures.

Some apple diseases are found wherever the ap - ple is grown, others are restricted to certain regions. The following tentative list is given in the hope that it may aid inspectors in making a diagnosis.

Southern United States.
Bitter rot.
Blotch, (occasionally found in Pennsylvania, Ohio, Illinois and Kansas).

Northern and Northeastern United States, the mountain districts of the South and Oregon and parts of Washington.

Scab.

Northwestern United States.
Anthracnose.
Blue mold.

Northeastern United States; also Arkansas.
Fruit spot.

Central, Northern and Eastern United States
Black rot.

New York and Michigan.
Pink mold rot following scab.

BROWN ROT OF STONE FRUITS.

The discussion of this disease in the handbook proper is necessarily somewhat limited in space. There are, however, certain questions relating to it which need to be taken up in greater detail. One of these is the question of infection. For a clear understanding of it we may divide the types of infection into three main groups, which, of course, thoroughly intergrade. The first type of inoculation which, indeed, may scarcely be considered an infection, consists of the presence of spores dry and not germinated on the surface of the fruit. Brown rot spores are omnipresent, in the humid eastern portions of the United States, their distribution being favored by the fact that they are produced in immense quantities on every brown rotted fruit and are readily blown about by the wind. Necessary conditions for the germination of the spores and their penetration into the flesh of the peach include moisture, such as drops of rain or dew, or the sweat drops on peaches which are practically the same as dew, and at least moderately high temperature.

The second type of infection may be called the invisible or microscopic type. It may be described as the stage in which the spores have germinated and penetrated a few cells of the fruit but either because of lack of time, or drying out, or low temperatures, have not discolored a spot large enough to be seen by the naked eye. All infections

pass necessarily through this stage, though the time of remaining in this stage varies greatly with moisture and temperature conditions. These microscopic infections cannot be detected in the orchard nor in the packing houses.

The third type of infections consists of those which have developed into a visable spotting. At first these may be very small, mere pin-point or pin-head specks. But under favorable conditions they develop over night into spots a half inch or more in diameter and in two or three days into lesions involving the whole fruit. Breaks in the skin due to mechanical injury of any kind, to insect injury or to the cracking that often accompanies peach scab, all tend to increase these infections.

Spraying, careful handling in the orchard and packing house, and prompt refrigeration tend to prevent or reduce the amount of all three types of infection. If the temperature is high, if there is heavy rainfall with consequent high atmospheric humidity the growth of the fungus is favored and the fruit is rendered sappy and susceptible to the disease. The object of refrigeration, therefore, is to prevent the germination of the spores, to retard the spread of microscopic or invisible infections and to prevent the growth of the minute but visible infections.

The importance of temperature in relation to brown rot can hardly be over-emphasized. A study of the data on all peach certificates issued by the inspection service up to August 1, 1919, shows that the heavy decay - an average of 20 per cent - due to the brown rot fungus is nearly always closely correlated with high car temperatures. Observations during the summer of 1919 on refrigerated cars of peaches coming from the South to Potomac yards (near Washington, D.C.) to Jersey City and to Chicago have shown temperatures between 50 degrees and 70 degrees F. In practically all of these cases, the higher the temperature the greater was the loss from brown rot.

There is another fact which has been known for years but which was unsupported by accurate data

till the summer of 1919; namely, that if the cars are loaded five layers deep the fifth or top layer often suffers much more seriously from decay than any of the others. It was found in many cases that there was an increase of 10 degrees F. in the temperature of the top layer over that of the lowermost layer. Inspection of the fruit at terminal markets in such a case has shown brown rot present to the extent of over 40 per cent in the fifth layer as contrasted with 9 per cent in the bottom layer. Detailed figures for 77 carloads of peaches are as follows:

1st (bottom)	layer	6.41	per cent	of	decay.
2nd	"	9.62	"	"	"
3rd	"	16.33	"	"	"
4th	"	32.08	"	"	"
5th	"	46.42	"	"	"

PINEAPPLE BLACK ROT.

As stated later in this handbook, black rot(due to the fungus Thielaviopsis) is the most serious disease of the pineapple fruit. It is found both in the field and on the market but is most destructive on the market. A summary of the data from inspection certificates issued on 56 cars of pineapples arriving at various terminal markets during the period from January 8 to June 23, 1919 shows an average of 27.1 per cent of the fruits affected by black rot. There is no way of knowing how many of these cars had been repacked before being inspected but it is worthy of note that the average on the Chicago market where inspection is made before repacking, was 42.4 per cent. Temperatures were not recorded for all of the 56 cars but where taken they ranged from 60 degrees to 80 degrees F. Where heavy decay occurred it was generally associated with high temperature.

MATURITY.

In the inspection of fruits the question of maturity often comes up for settlement. Whatever

the fruit may be the inspector will naturally base his judgment on color, firmness, flavor and perhaps partially on size. These characteristics will vary somewhat with the season and quite considerably with the place of origin of the shipment. Jonathan apples from the Northwest may appear immature if judged by Missouri or Virginia standards when in reality they meet all Northwestern shipping requirements for maturity. Or, Jonathan apples grown on sandy soil especially in a hot season, may color up earlier and consequently appear more mature than Jonathans grown under conditions less favorable to the production of high color.

But aside from such variations, seasonal or regional, there are others, less easy to relate to any cause though still of importance in their effect on the value of the fruit. Shrivelling or flabbiness in apples and peaches is an example. It may be due to immaturity, but it may also be due to delayed storage or shipment, the fruit having been held meantime under conditions which allowed a heavy water loss. Flabby peaches are often thought to be the last of the crop, the cleanings of the orchard; that is, fruit which had ripened after a fashion but improperly and perhaps has hung on the tree too long and lost water there. Such fruit is clearly overmature. The difficulty comes in deciding why the peach is flabby. If it is green the flabbiness is probably due to delayed shipment or storage; if ripe, to improper ripening.

Pears from the Northwest occasionally show a brown mushy condition, especially in the upper layer of the load, which might be mistaken for decay but is usually a sign of overmaturity. Occasionally it may result from poor refrigeration during shipment.

IMPORTANCE OF THE WORK OF INSPECTORS.

It may seem to inspectors that some of the information asked for on the certificate is unnecessary; that the taking of temperatures, the careful diagnosis of diseases, are not so important but that they can be neglected when inspection work is heavy. But in many cases it is the presence or ab-

sence of information on these points that determines the value of the inspection to the person who requested it. Enough has been said concerning the correlation between temperature and decay to show the importance of recording the temperature in all cars inspected. Settlement of disputes between carrier and shipper or carrier and receiver often hinges on this very point. Knowledge concerning it is also of great assistance to the pathologists in interpreting the data on inspection certificates. This interpretation in turn should have, and undoubtedly will have, a considerable influence in the future on the policy to be followed by shippers, carriers and receivers in the marketing of various crops.

The proper diagnosis of disease is important, for under present conditions it often goes far toward fixing the responsibility for loss. If Rhizopus rot or bruises on peaches are mistaken for brown rot and so named on the certificate, the railroad or the receiver or both are likely to try to throw the loss on to the shipper. Bruises and Rhizopus rot may be his fault but brown rot, a field disease, certainly is according to the position taken at present by the railroads and the trade. The justice of that position is a matter for further investigation but the fact that it is taken by certain interested parties should cause inspectors to use extreme care. The same applies to stem-end rot of citrus fruits, black rot, brown rot and bitter rot of apples and gray mold rot of strawberries. The inspector should remember that what he says on the certificate means dollars and cents to some one, a fact which makes his position one of great responsibility. And the only way in which he can carry this responsibility without worry and uncertainty is to have confidence in himself, basing that confidence on careful work and a thorough knowledge of the matters with which he has to deal. Such knowledge is conditioned on study; study of his own market, of market conditions generally, and of all available literature

on market problems. Literature means bulletins, of course, and products circulars, but above all, the vegetable and fruit disease handbooks, which have been prepared expressly for the inspector's use.

BIBLIOGRAPHY

Diseases of Fruits.

Apples:

Apple tree anthracnose. H. S. Jackson. Ore. Crop Pest and Hort. Biennial Rept., 1911-1912-1913.

Apple tree anthracnose. H. S. Jackson. Ore. Agr. Exp. Sta. Circ. 7, p. 2-4, 1911.

Apple bitter-rot and its control. John W. Roberts and Leslie Pierce. U.S. Dept. Agr. Farmers' Bul. 938, Apr., 1918.

The bitter-rot of apples. Hermann von Schrenk and Perley Spaulding. U.S. Dept. Agr. Bul. 44, 1903.

Bitter rot of apples. T. J. Burrill. Ill. Agr. Exp. Sta. Bul. 118, p. 555-608, 1907.

Bitter rot of apples. T. J. Burrill and J. C. Blair. Ill. Agr. Exp. Sta. Bul. 77, p. 351-366, 1902.

The control of apple bitter-rot. W. M. Scott. U.S. Dept. Agr. Bul. 93, 1906.

Sources of the early infections of apple bitter-rot. J. W. Roberts. Jour. Agr. Research. v. 4, No. 1, p. 59-64, Apr., 1915.

The sources of apple bitter-rot infections. John W. Roberts. U. S. Dept. Agr. Bul. 684, Aug., 1918.

Black rot, leaf spot, and canker of pomaceous fruits. L. R. Hesler. N. Y. (Cornell) Agr. Exp. Sta. Bul. 379, 1916.

Apple leaf spot caused by Sphaeropsis Malorum. W. M. Scott and J. B. Rorer. U.S. Dept. Agr., Bur. Pl. Indus. Bul. 121, 1908.

Apple blotch, a serious disease of southern orchards. W. M. Scott and J. B. Rorer. U.S. Dept. Agr., Bur. Pl. Indus. Bul. 144, 28 p., 6 pl., 1909.

The control of apple blotch. D. E. Lewis. Kans. Agr. Exp. Sta. Bul. 196, p. 517-574, 18 fig., 1913.

Apple blotch and its control. John W. Roberts. U.S. Dept. Agr. Bul. 534, 1917.

The Jonathan fruit-spot. W. M. Scott and John W. Roberts. U.S. Dept. Agr., Bur. Pl. Indus. Circ. 112, Feb., 1913.

Apple rot in Illinois. G. P. Clinton. Ill. Agr. Exp. Sta. Bul. 69, p. 189-224, 1902.
Apple rust. N. J. Giddings and A. Berg. W. Va. Exp. Sta. Bul. 154, 1915.
The cedar apple fungi and apple rust in Iowa. L. H. Pammel. Ia. Agr. Exp. Sta. Bul. 84, 1905.
Cedar rust. W. H. Hein. Insect pest and plant disease Bureau of Neb. Circ. 1, 1908.
Control of apple rust by spraying. N. J. Giddings and D. C. Neal. Phytopathology, v. II, No. 6, p. 258, 1912.
Experiments on Control of cedar rust of apples. H. S. Reed, J. S. Cooley and C. H. Crabill. Va. Agr. Exp. Sta. Bul. 203, 1914.
Infection and immunity in apple rust. N. J. Giddings. W. Va. Agr. Exp. Sta. Bul. 170, Dec., 1918. (Technical bulletin).
Some investigations of the cedar rust fungus. G. H. Coons. Neb. Agr. Exp. Sta. Rpt. 25, p. 217 1912.
Scab disease of apples. Errett Wallace. N. Y. (Cornell) Agr. Exp. Sta. Bul. 335, Sept., 1913.
Effect of temperature aeration and humidity on Jonathan spot and scald of apples in storage. Chas. Brooks and J. S. Cooley. Jour. Agr. Research, v. 11, No. 7, p. 287-218, 23 fig., pl. 32-33. Literature cited, p. 317-318, 1917.
Apple scald. Chas. Brooks, J. S. Cooley and D. F. Fisher. Jour. Agr. Research, v. 16, no. 8, p. 195-217, 11 fig., 1918.
Nature and control of apple-scald. Chas. Brooks, J. S. Cooley and D. F. Fisher. Jour. Agr. Research, v. 18, no. 4, p. 211-240, Nov., 1919.
The more important insect and fungous enemies of the fruit and foliage of the apple. A. L. Quaintance and W. M. Scott. U. S. Dept. Agr. Farmers' Bul. 492, 1917.
Some apple diseases and their treatment. Chas. Brooks N. H. Agr. Exp. Sta. Bul. 157, Apr., 1912.

Citrus Fruits:

Citrus canker. C. W. Edgerton. La. Agr. Exp. Sta. Bul. 150, 1914.
Pseudomonas citri, the cause of citris canker. Clara H. Hasse. Jour. Agr. Research, v. 4, no. 1, p. 97-100, Apr., 1915.

Citrus diseases of Florida and Cuba compared with those of California. Howard S. Fawcett. Calif. Agr. Exp. Sta. Bul. 262, 1915.

A comparison of some citrus conditions in Florida, Cuba and California. Howard S. Fawcett. Monthly Bulletin, State Comm. of Hort., v. 5, p. 321-336, Sept., 1916.

Stem-end Rot of citrus fruits. H. S. Fawcett. Fla. Agr. Exp. Sta. Bul. 107, Oct., 1911.

A simple and effective method of protecting citrus fruits against stem-end rot. John N. Rogers and F. S. Earle. Phytopathology, v. VII, no. 5, p. 361-367, Oct., 1917.

Disease of citrus fruits. P. H. Rolfs, H. S. Fawcett and B. F. Floyd. Fla. Agr. Exp. Sta. Bul. 108, Nov., 1911.

Florida citrus diseases. H. E. Stevens. Fla. Agr. Exp. Sta. Bul. 150, Aug., 1918.

Citrus diseases of Porto Rico. John A. Stevenson. Jour. Dept. Agr. Porto Rico, v. II, no. 2, p. 43-119, Apr., 1918.

A study of the effects of freezes on citrus in California. H. J. Webber and others. Calif. Agr. Exp. Sta. Bul. 304, Jan., 1919.

Brown rot of lemons. R. E. Smith. Calif. Agr. Exp. Sta. Bul. 190.

Frost protection in lemon orchards. A. D. Shamel, L. B. Scott and C. S. Pomeroy. U. S. Dept. Agr. Bul. 821, Jun., 1920.

A spotting of citrus fruits due to the action of oil liberated from the rind. Howard S. Fawcett. Calif. Agr. Exp. Sta. Bul. 266, Feb., 1916.

The decay of oranges while in transit from California. G. Harold Powell, and A. V. Stubenrauch, L. S. Tenny, H. J. Eustace, G. W. Hosford, and H. M. White. U. S. Dept. Agr. Bul. 123, Mar., 1908.

Propagation and marketing of oranges in Porto Rico. H. C. Henricksen. Porto Rico Agr. Exp. Sta. Bul. 4, 1904.

Cranberries:

Cranberry diseases. C. L. Shear. U. S. Dept. Agr. Bul. 110, 1907.

End rot of cranberries. C. L. Shear. Jour. Agr. Research, v. 11, no. 2, p. 35-42, 1917.

A method for studying the humidity relations of fungi in culture. Neil E. Stevens. Phytopathology, v. VI, no. 6, p. 428-432, 1916.

Observations on the spoilage of cranberries due to lack of proper ventilation. Neil E. Stevens, B. A. Rudolph. Mass. Agr. Exp. Sta. Bul. 180, 1917.

The reduction of cranberry losses between field and consumer. C. L. Shear, Neil E. Stevens, and R. B. Wilcox. Proc. Amer. Cranberry Grow. Assoc., v. 48, p. 7-10, 1918.

Report of cranberry substation for 1916. H. J. Franklin. Mass. Agr. Exp. Sta. Bul. 180, p. 183-234, 1917.

Report of cranberry substation for 1915. H. J. Franklin. Mass. Agr. Exp. Sta. Bul. 168, 1916.

Spoilage of cranberries after picking. C. L. Shear. Proc. 48th Ann. Conv. Amer. Cranberry Grow. Assoc., p. 6-9, 1917.

Spoilage of cranberries after harvest. C. L. Shear, Neil E. Stevens, R. B. Wilcox and B. A. Rudolph. U. S. Dept. Agr. Bul. 714, Aug. 1918.

Temperatures of the cranberry regions of the United States in relation to the growth of certain fungi. Neil E. Stevens. Jour. Agr. Research, v. 11, no. 10, p. 521-529, 1917.

Pineapples:

Some fungous diseases of economic importance. B. T. Galloway. U. S. Dept. Agr. Bul. 171, Jun., 1910.

Peaches:

Control of peach bacterial spot in southern orchards. John W. Roberts. U. S. Dept. Agr. Bul. 543, Aug., 1917.

The control of peach brown-rot and scab. Wm. M. Scott and T. Williard Ayres. U. S. Dept. Agr. Bul. 174, Mar., 1910.

Spraying peaches for the control of brown-rot, scab, and curculio. W. M. Scott and A. L. Quaintance. U. S. Dept Agr. Farmers' Bul. 440, Mar., 1911.

The brown rot of peaches, plums and other fruits. A. L. Quaintance. Ga. Agr. Exp. Sta. Bul. 50, Oct., 1900.

Peach supply and distribution in 1914. Wells A. Sherman, Houston F. Walker, and L. Herbert Martin. U. S. Dept. Agr. Bul. 298, Aug., 1915.

Pears:

Controlling important fungous and insect enemies of the pear in the humid sections of the Pacific northwest. D. F. Fisher and E. J. Newcomer. U. S. Dept. Agr. Farmers' Bul. 1056, Sept., 1919.

Prunes:

Brown-rot of prunes and cherries in the Pacific Northwest. Chas. Brooks and D. F. Fisher. U. S. Dept. Agr. Bul. 368, Mar., 1916.

Strawberries:

A destructive strawberry disease. F. L. Stevens. Science, n. s., v. 39, no. 1017, p. 949-950. 1914.

Pathological histology of strawberries affected by species of Botrytis and Rhizopus. Neil E. Stevens. Jour. Agr. Research, v. 6, no. 10, p. 361-366, Jun., 1916.

Rhizopus rot of strawberries in transit. Neil E. Stevens and R. B. Wilcox. U. S. Dept. Agr. Bul. 531, May, 1917.

Some new strawberry fungi. F. L. Stevens and Alvah Peterson. Phytopathology, v. VI, no. 3, p. 258-267, 1916.

Three strawberry fungi which cause fruit rots. F. L. Stevens. Science, n. s., v. 41, no. 1068, p. 912-913, 1915.

Some changes produced in strawberry fruits by Rhizopus nigricans. Neil E. Stevens and Lon A. Hawkins. Phytopathology, v. VII, no. 3, p. 178-184, Jun., 1917.

Further studies of the rots of strawberry fruits. Neil E. Stevens and R. B. Wilcox. U. S. Dept. Agr. Bul. 686, Jun., 1918.

Diseases of Vegetables:

Handbook of the diseases of vegetables occurring under market, storage, and transit conditions. Geo. K. K. Link and Max W. Gardiner. U. S. Dept. Agr. May 24, 1919.

Spraying:

Apple spraying experiments in 1916 and 1917. W. J. Morse. Me. Agr. Exp. Sta. Bul. 271, May, 1918.

Commercial Bordeaux mixtures: how to calculate their values. Errett Wallace and L. H. Evans. U. S. Dept. Agr. Farmers' Bul. 994, Jun., 1918.

Common orchard troubles, spray mixtures and spray calender. F. W. Faurot. Mo. State Fruit Exp. Sta. Bul. 23, Dec., 1912.

Field experiments in spraying apple orchards. Ill. Agr. Exp. Sta. Bul. 185, Feb., 1916.

The field testing of copper-spray coatings. J. R. Winston and H. R. Fulton. U. S. Dept. Agr. Bul. 785, Mar., 1919.

Fungicides and their use in preventing diseases of fruits. M. B. Waite. U. S. Dept. Agr. Farmers' Bul. 243, Mar., 1906. Reprinted Jan., 1915.

Information about spraying for orchard insects. A. L. Quaintance. U. S. Dept. Agr. Yearbook 1908, p. 267-288.

Orchard spraying versus dusting. N. J. Giddings. Va. Agr. Exp. Sta. Bul. 167, Nov., 1918.

Orchard spraying. N. J. Giddings, W. H. Alderman, and W. E. Rumsey. W. Va. Agr. Exp. Sta. Circ. 7, Mar., 1913.

Orchard spraying. D. E. Lewis. Kans. Agr. Exp. Sta. Bul. 203, Feb., 1915.

Spraying experiments in Nebraska. Ralph J. Cooper. Neb. Agr. Exp. Sta. Bul. (Research) no. 10, Apr., 1917.

A spraying manual. Depts. of Plant Pathology, Horticulture and Entomology, etc. Extension Division, Univ. of Ark. and U. S. Dept. of Agr., Feb., 1916.

Storage and Transportation:

The apple in cold storage. G. Harold Powell and S. H. Fulton. U. S. Dept. of Agr., Bur. Pl. Indus. Bul. 48, 66 p., 6 pl., 1903.

Cold storage for Iowa grown apples. S. A. Beach and H. J. Eustace. Ia. Agr. Exp. Sta. Bul. 108, p. 391-414, 1909.

Cold storage for Iowa grown apples. Laurenz Greene. Ia. Agr. Exp. Sta. Bul. 144, p. 355-378, 2 fig., 1913.

The handling and storage of apples in the Pacific Northwest. H. J. Ramsey, A. W. McKay, E. L. Markell and H. S. Bird. U. S. Dept. Agr. Bul. 587, 32 p., 7 pl., 1917.

Heavy loading of freight cars in the transportation of Northwestern apples. H. J. Ramsey. U. S. Dept. Agr., Bur. Markets Doc. 13, Jul., 1918.

Some results of the apple storage investigation by U. S. E. L. Markell. Better Fruit, v. 10, no. 5, p. 19-26, 1915.

Apple market investigations, 1914-15. Clarence W. Moomaw and M. M. Stewart. U. S. Dept. Agr. Bul. 303, Sept., 1915.

The handling and shipping of fresh cherries and prunes from the Willamette Valley. H. J. Ramsey. U. S. Dept. Agr. Bul. No. 331, 1916.

Factors governing the successful storage of California table grapes. A. V. Stubenrauch and C. W. Mann. U. S. Dept. Agr. Bul. 35, Dec., 1913.

Factors governing the successful shipment of oranges from Florida. A. V. Stubenrauch, H. J. Ramsey and others. U. S. Dept. Agr. Bul. 63, Mar., 1914.

Factors governing the successful shipment of red raspberries from the Puyallup Valley. H. J. Ramsey. U. S. Dept. Agr. Bul. 274, 1915.

Factors in transportation of strawberries from the Ozark region. V. W. Ridley. U. S. Dept. Agr., Bur. Markets Doc. 8, Mar., 1918.

The influence of refrigeration on the fruit industry. W. A. Taylor. U. S. Dept. Agr. Yearbook, 1900, p. 561-580.

The cold storage of small fruits. S. H. Fulton. U. S. Dept. Agr. Bul. 108, 1906.

The handling of fruit for transportation. G. Harold Powell. U. S. Dept. Agr. Yearbook, 1905, p. 349-362.

Suitable storage conditions for certain perishable food products. Chas. J. Brand. U. S. Dept. Agr. Bul. 729, Jul., 1918.

Miscellaneous:

California plant diseases. R. E. Smith and E. H. Smith. Calif. Agr. Exp. Sta. Bul. 218, 1911.

Diseases of Illinois fruits. H. W. Anderson. Ill. Agr. Exp. Sta. Bul. 241, p. 1-155, 1920.

Notes of New York plant diseases. F. C. Stewart. N. Y. (Geneva) Agr. Exp. Sta. Bul. 328, p. 316, 1910.

A brief handbook of the diseases of cultivated plants in Ohio. A. D. Selby Ohio Agr. Exp. Sta. Bul. 214, 1910.

Insects of a citrus grove. J. R. Watson. Fla. Agr. Exp. Sta. Bul. 148, 1918.

Plant pathology today. C. L. Shear and Neil E. Stevens. Scientific Monthly, v. 7, 235-243, Sept., 1918.

Pathological problems in the distribution of perishable plant products. C. L. Shear. Brooklyn Bot. Gard. Mem., v. 1, p. 415-422, 1918.

Treatment of fungus diseases. L. H. Pammel. Ia. Agr. Exp. Sta. Bul. 13, p. 41, 1891.

The handling and shipping of fresh cherries and prunes from the Willamette Valley. H. J. Ramsey. U. S. Dept. Agr. Bul. 331, Jan. , 1916.

KEY TO APPLE DISEASES.

I. Disease producing no discoloration of skin.

1. Apple brown on inside extending in regular pattern toward the center. Mostly on summer and over-ripe apples. ----------
Internal breakdown.

2. Apple showing fungus rot at core. Apples from Northwest. ----------
Alternaria Core-rot.

II. Injury confined to the surface, or affecting the underlying tissues only slightly.

A. Discolored area of an irregular pattern.

1. Discolored area producing irregular light brown areas on apples held in storage. The affected area confined to the skin only, and seldom if ever, occurring on red fruit surfaces. -----
Scald.

2. Discolored area may be in the form of spot, burn or russet, sometimes deforming the fruit. Flesh mostly sound underneath. ----------
Spray Injury.

3. Discoloration on the surface of the skin. Due to a fungus which can be easily scraped off.

a. Sooty black discoloration which may or may not be accompanied by small round black fly-speck-like bodies. ----------
Sooty-blotch and Fly-speck.

B. Discolored area definite, sometimes sunken.

1. Areas small, brownish, circular, only skin deep. ----------
Jonathan Spot.

2. Skin discolored somewhat depressed also affecting tissues underneath, the flesh underneath the spot being corky. ----------
Bitter-pit.

3. Discolored area large, irregular, rather depressed flesh underneath rather leathery, becoming corky. .....

Bruise.

C. Discolored area definite, raised.

1. Injury often crescent shaped, russeted, raised. .....

Curculio Injury.

D. Discolored areas glassy.

1. Skin, if affected, has a water-soaked appearence, the core also has the same appearance. Usually no superficial evidence of disease. .....

Water Core.

III. Disease discoloring skin and sometimes deforming the fruit, but not producing rot.

A. Diseased area discolored, surface irregular and sometimes cracked.

1. Deformed area yellowish-green; later stages small yellow pimple-like bodies arise. .....

Rust.

2. Affected area black.

a. Blackened area with an irregular margin, feather-like, varying in size up to one-half inch. In bad cases margin entire, spots large, sunken, dotted with minute, shiny pimple-like bodies. Apples mostly from Middle West. .....

Blotch.

b. Blackened area with entire margin; the broken skin partly covers the blackened area. Blackened area usually sooty; in old lesions the soot disappears and the spot becomes russeted. Spots vary greatly in size, up to an inch or more in diameter. .....

Scab.

c. Blackened area small surrounded by red of deeper color, or a band of darker green. Darkened area has a speckled appearance.

Fruit Spot.

B. Diseased area sometimes discolored, surface irregular but not cracked.

1. The deformed surface may have a small discolored portion in the center. If a section is cut through the center of the spot sometimes a brown streak can be found extending into the flesh. ----------

Stigmonose.

IV. Disease discoloring the skin and producing a rot.

A. Rots produced are somewhat conical in shape with apex toward the core.

1. Diseased area more or less zoned.

a. Affected area giving zoned appearance. In old rots pimple-like bodies appear. Rot dark brown to brownish black. Somewhat firm.

Black rot.

b. Affected area having zones or concentric rings formed by small pimple-like bodies which usually produce pink, sticky masses, which turn brown with age. Beginning spots surrounded by a red band; on a red skinned apple the color is slightly intensified. Apples usually from the South. ----------

Bitter rot.

c. Soft rot at first showing small light brown areas which enlarge. Zones in later stages formed by fruiting bodies. Apples from Northwest. ----------

Anthracnose.

2. Rots not zoned but rather firm.

a. A brown rot, tough, white to grey fungus appearing over the surface of the apple. Affected area at no time shows black pimples characteristic of black rot. ----------

Brown rot.

3. Rots not zoned: rather soft and watery.

a. Soft rot somewhat watery showing tufts of a blue colored fungus. Affected tissue light brown. ----------

Blue mold.

b. Soft rot originating at an old scab injury, pink with sometimes white, fluffy fungous growth. ----------

Pink mold.

B. Rot-like area not conical, forming an irregular pattern.

1. Affected flesh showing no fungus growth. No bad odor or taste, apples having been in storage. ----------

Soft scald.

APPLE ALTERNARIA ROT.

APPLE: ALTERNARIA ROT.

Cause: A fungus (Alternaria).

This disease occurs in two fairly distinct types which at times intergrade. One type, found so far only on apples in cold storage, is characterized by rather small, firm, slightly sunken areas which may be brown around the edge but are covered for the most part by a rough coal black crust. This crust on superficial examination seems to contain pycnidia but examination under the microscope shows that no pycnidia are present.

The other type occurs on apples in cold storage and also develops from the black-crust type after apples are removed from storage. It is characterized by rather firm, slightly sunken, rotten areas which are most commonly dark brown to black but may occasionally be light yellowish brown to almost gray.

On Rome Beauty from the Eastern United States, the rot frequently occurs at the stem end, in the form of a sunken ring of diseased tissue half an inch or more in width, close around the stem. It has also been found as a rot at the core, especially in C grade Winesaps showing severe worm injury.

Alternaria rot can be distinguished from Anthracnose by its uniform color, that is, by the absence of the tan spots so characteristic of Anthracnose; from black rot by the absence of pycnidia and of alternating zones of light and dark brown; and finally, from bitter rot by the absence of concentrically arranged pink spore masses. A further point to be remembered in connection with this disease is that it is usually a rot of stored apples.

The disease was found on practically all lots of Rome Beauty inspected in Chicago during the shipping season of 1919-20. It has also been found on cellar stored Romes from the East. Other varieties sometimes found infected are Northwestern grown Winesaps, Jonathan, Ben Davis and Stayman Winesap.

APPLE ANTHRACNOSE.

APPLE: ANTHRACNOSE.

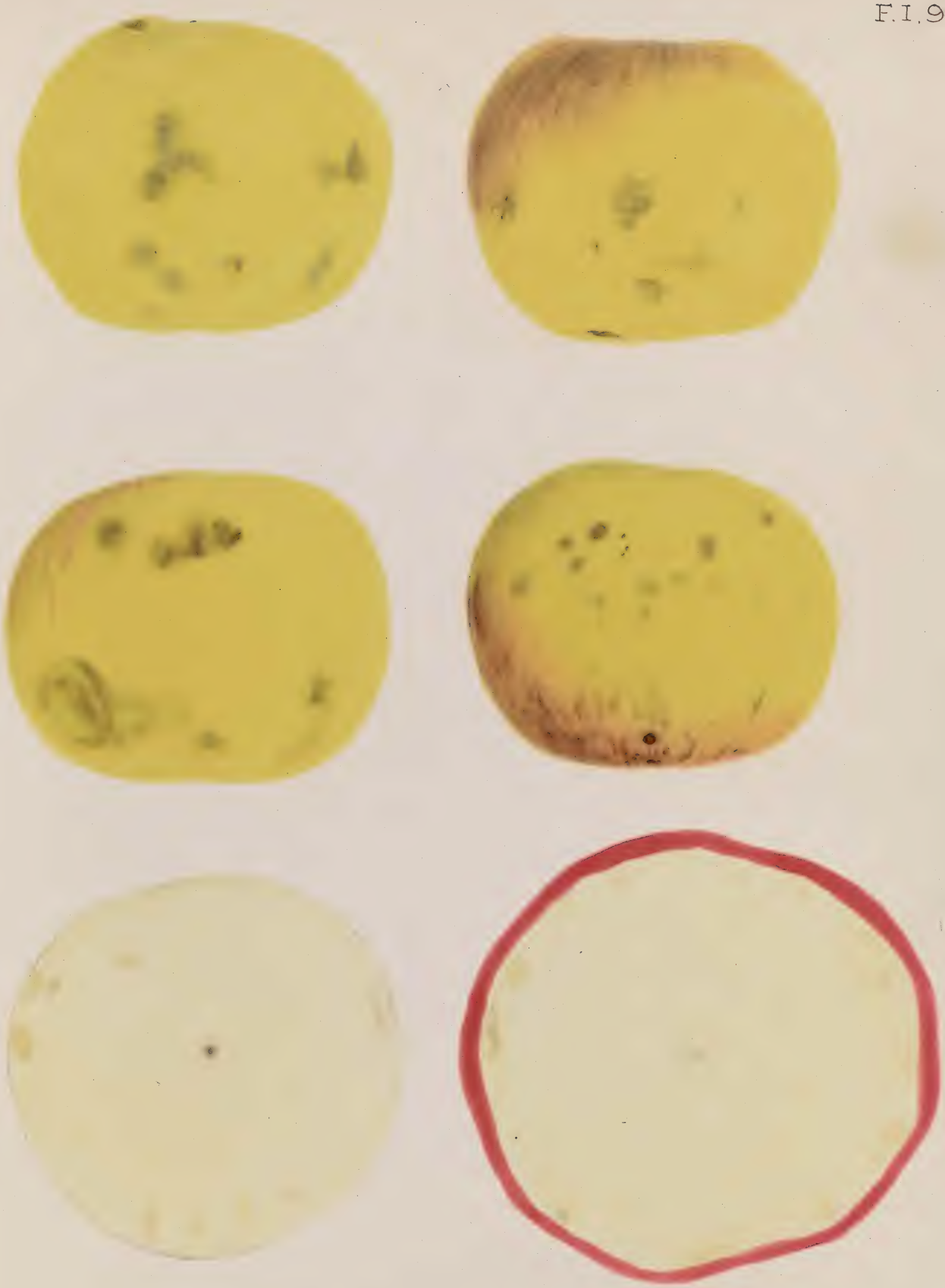
Cause: A fungus (Neofabraea malicorticis).

This disease is characterized by slightly sunken brown spots with tan to faintly green centers, occurring anywhere on the apple and varying in size from mere specks to lesions an inch or more in diameter. In small spots the tan or green-colored portion is only a point at the center; in larger ones it may cover one-third to one-half the spot. The rot produced is fairly soft, but has no odor. Under favorable conditions of moisture and temperature (though rarely on the market) the fruiting bodies of the fungus may develop in concentric circles on the spots; when these open they disclose creamy masses of spores.

Anthracnose is distinguished from all other rots of apples by the tan or light green color at the center of the spots and by the cream-colored masses of spores. The affected tissues are not as dark brown as in black rot nor as soft and mushy as in blue mold rot.

Within the United States the disease is confined to Washington and Oregon; and in this region is second in importance only to apple scab. Outside of the United States it is found only in British Columbia. Baldwin, Spitzenberg, and Jonathan seem to be the most susceptible varities while Rhode Island Greening, Yellow Newtown and Gravenstein are rather less susceptible. The varieties most commonly affected on the market are Spitzenberg and Yellow Newtown. Losses on the market are not great even on these.

The disease develops in storage and transit, but little is known as to whether or not it spreads under these conditions. It causes a serious canker of twigs, branches and even the trunks in the case of young trees, hence control must rest on the cleaning and painting, or the removal, of such cankers. Careful spraying with Bordeaux mixture is effective in preventing the spread of the disease from cankers to healthy limbs.



APPLE BITTER PIT

APPLE: BITTER PIT

Cause: probably a deranged water relationship.

Bitter pit is characterized by sunken spots, usually on the lower or blossom half of the apple, varying in diameter from one-sixteenth to one-fourth of an inch. The spots resemble bruises and are sometimes wrongly ascribed to hail injury. In the early stages their color is darker red than the rest of the surface on a red variety, and darker green on a green variety; the final color is brown to deep brown. Underneath the spots are corky masses of brown dead cells, extending into the flesh for a sixteenth to an eighth of an inch, and closely connected with the water conducting system of the fruit. Similar brown spots, similarly related to the water system may also occur deep in the flesh. In fact, examination by means of the X-ray has shown that bitter-pit develops on the inside of the fruit before it is apparent on the outside.

Hollow apple or crinkle, found in the western United States is thought to be merely a case in which large portions of the apple have suffered from the same kind of injury as that which produces the bitter pit spots.

The disease is nonparasitic. No connection has ever been shown between the spots and fungi or bacteria, but the real cause is still in doubt. Various theories have been advanced but none of them has yet been established as the true explanation. Since the spots are found in close connection with the water vessels the suggestion has been made that they are in some way related to the water supply of the fruit. It is known that either a deficient or an excessive supply of water or intermittent weather conditions may cause bitter pit but how this is done is not known.

Bitter pit spots can be distinguished from New England fruit spot by the fact that they are decidedly sunken and bear considerable resemblance to bruises. The fruit spots are not sunken and usually appear speckled, due to the presence of fruiting pustules of the fungus. These specks never develop on bitter pit spots. Bruises differ from bitter pit spots in that the skin appears as

if pushed in rather than sunken. Stigmonose (insect injury on the surface of the apple)bears some resemblance to bitter pit but can be distinguished from it by the presence of a minute puncture at each sunken spot, by the darker brown color of the mass of cells which makes up the spot, and by the fact that the spots are nearer the surface than those of bitter pit. The latter are often found deep in the flesh.

Bitter pit may develop toward the end of the growing season or it may not appear until the fruit has been placed in storage. It occurs in all the apple growing regions of the world but is most serious in America and Australia. In the United States practically all varieties are susceptible but most of the damage is done on a relatively small number. Chief among these is Baldwin (hence the name Baldwin spot sometimes used), followed by Northern Spy, Rhode Island Greening, Tomkins King, York Imperial, Arkansas (Mammoth Black Twig) and Yellow Newtown.

At present bitter pit is considered one of the important apple diseases of the world. Losses from it are due to a blemishing of the fruit in mild cases, or to an actual and serious reduction in quality in severe ones, as for example when half of the crop of an orchard is found affected, either at picking time or after being held in storage for awhile. The keeping quality of fruit showing bitter pit is not affected; that is, the spots do not pass over into a rot.

From the nature of the disease it will readily be seen that it cannot spread from one apple to another in transit or storage. It may and often does develop however, under such conditions,especially if the temperature is around 34 degrees F or above and the air is moist. Spots already present may enlarge to some extent or new ones develop,either on fruit affected when stored or on seemingly sound fruit from an orchard where a high percentage of the crop showed bitter pit.

Control in the orchard is a complex matter. This much can be recommended, that everything possible should be done to insure the production of

good crops well distributed over the tree year after year. This implies judicious pruning, thinning of the fruit, cultivation, a regular and judicious use of irrigation water, drainage where necessary-in fact anything which will tend to stabilize moisture conditions in the soil and in the tree. Control in storage can generally be effected by keeping the fruit at a temperature of 31 to 32 degrees F. in dry, well ventilated storage rooms.

APPLE BITTER ROT.

APPLE: BITTER ROT.

Cause: A fungus (Glomerella cingulata).

Bitter rot, as it appears on the market, is characterized by brown definitely limited spots varying in size from mere specks to lesions involving the whole side of an apple. In extreme cases the entire fruit may be rotted. Spots smaller than an eighth of an inch in diameter - not common on the market - usually take the form of brown blisters while larger ones are somewhat sunken. The decayed tissues are rather soft and watery. Contrary to the suggestion given by the name bitter rot they are not generally bitter. Spots half an inch in diameter or larger usually show, over the central portion, spore masses or spore heaps which may or may not be arranged in concentric circles.

Under orchard conditions these spore-masses are pink or cream-colored at first, later becoming dark. In storage they may not show the pink color at all, being merely a dirty cream color at first and dark later.

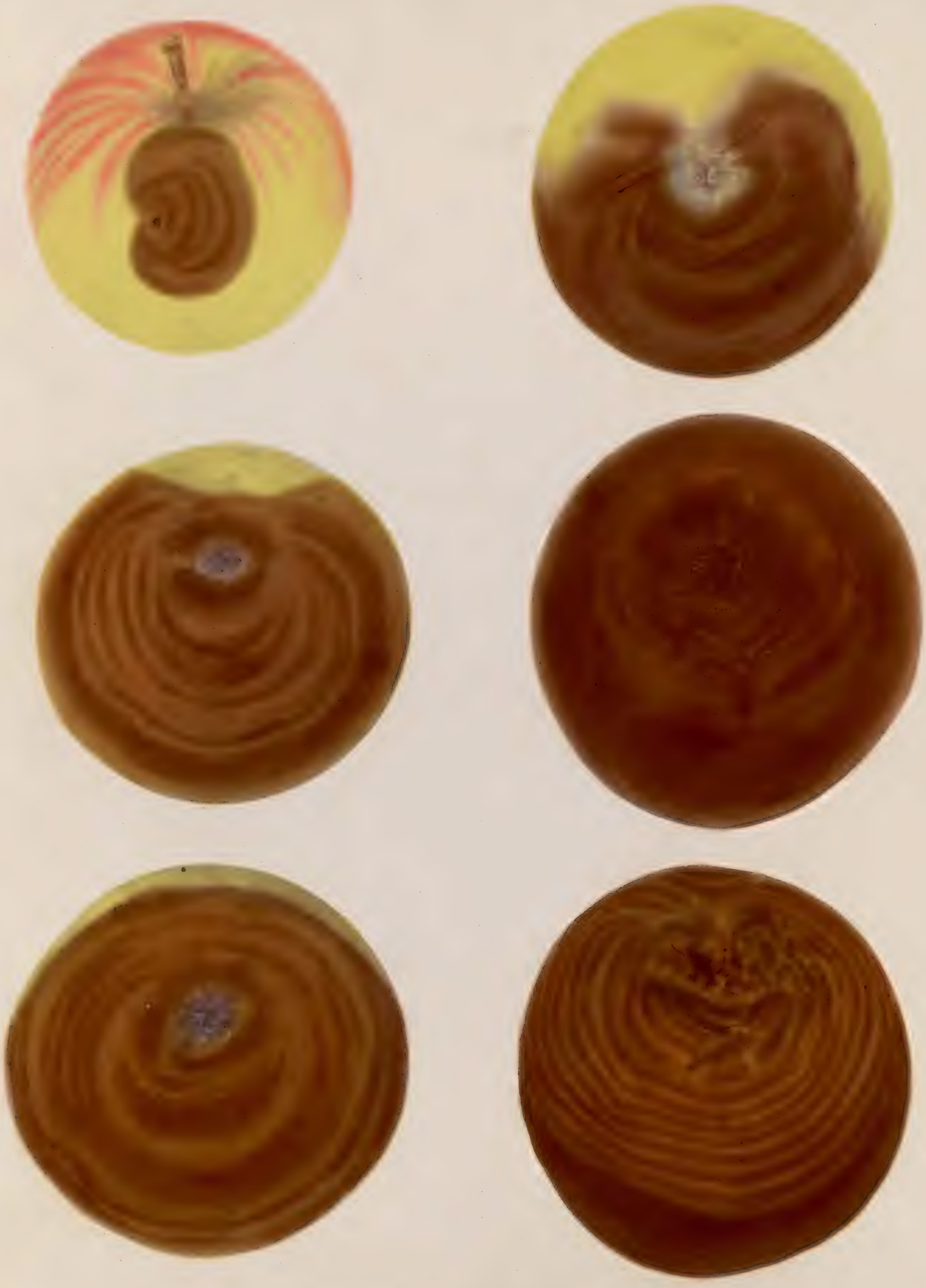
The arrangement of these spore masses and their color serve to distinguish the disease from black rot,in which the pycnidia (spore producing bodies) are always black and scattered irregularly over the diseased area. Bitter rot does not usually show the zones of different shades of brown often seen in black rot spots, but may do so in storage.

Bitter rot is sporadic, that is irregular in appearance, depending principally upon the kind of weather that prevails during the ripening period. If this is warm and moist the disease is almost sure to be serious; if dry and fairly cool it may not develop at all. Because of generally favorable weather conditions the disease is most common and most destructive in southern apple growing regions, over a territory extending from Virginia to Oklahoma.

The disease usually appears in the orchard in late June or early July but becomes most serious in August and September on well developed fruit hence the name ripe-rot often applied to it. The most susceptible varieties are Yellow Newtown (Albemarle Pippin) Huntsman, Willow, and Ben Davis. In Arkansas and Southern Missouri Jonathan and even Winesap are sometimes affected.

Because of the sporadic nature of the disease it occurs only irregularly on the market and even then chiefly in the southern part of the country. The reasons for this are probably two: (1) the fruit from bitter rot regions is shipped largely to southern markets and (2) temperatures during transit to these markets are more favorable to the development and spread of the disease than those to which it is exposed on the way to northern markets.

Bitter rot can be controlled by frequent thorough spraying with Bordeaux mixture beginning about the middle of June, and by removal of cankered limbs or by scraping and painting the cankers.



APPLE BLACK ROT.

APPLE: BLACK ROT

Cause: A fungus (Physalospora cydoniae).

This very common apple disease is characterized in its early stages by brown rotten spots, on any part of the apple, which vary greatly in size and are usually irregular in outline. Under field conditions they may show zones of different shades of brown, for which reason the disease is sometimes called ring rot. In late stages, the spots enlarge, become black and show numerous black pycnidia (spore-producing bodies) scattered irregularly over the surface of the spots.

Ripe fruit is more likely to be attacked than green fruit. Infection may take place at injured places in the skin, such as worm holes, bruises, limb scratches and hail injury. In these cases the rot develops freely if conditions are favorable, and finally involves the whole fruit. Infection may also follow spray or frost injury at the blossom end, producing what is known as blossom end rot. This is often bad on Ingram and Jonathan but may occur on other varieties. It may develop steadily from the time of infection and destroy the apple or it may progress for a short time, then become quiescent, only to start up again when conditions are more favorable, as for example when the fruit is barreled, and shipped to market without refrigeration.

The disease can be distinguished from bitter rot by the irregular distribution of the pycnidia, and by the failure to produce pink, cream-colored or black spore masses. It differs from blue mold rot by the fact that the diseased spots are dark brown to black and rather firm, not light brown and mushy; and from brown rot by the production of black pycnidia instead of gray spore-bearing tufts.

Black rot is found wherever apples are grown but is not a serious trouble in the Northwest. Practically all varieties are susceptible though the greatest losses usually occur on those ripening in the summer and fall. Rotting takes place in the orchard, in transit, in storage (especially in New England) and on the market. Under all these conditions the rot develops if the temperature is

favorable - about 77 degrees F. It does not ordinarily spread from one apple to another unless decay in the affected fruits has progessed so far that pycnidia are formed and spores discharged. Even then the spreading will be slow if there are no breaks in the skin to give easy entrance to the fungus.

Besides causing the fruit rot this fungus also causes a spot on the leaves, and cankers on the limbs and twigs from which infection spreads to the fruit.

Cutting out diseased limbs and twigs and cleaning and painting the cankers gives fairly good control but only in proportion to the thoroughness with which it is done. Spraying with Bordeaux is not very affective except for the leaf spot.

APPLE BLOTCH

APPLE: BLOTCH

Cause: A fungus (Phyllosticta solitaria).

Blotch spots are characterized by fan-shaped areas with fringed margins grouped around a common center, the diameter of the spots varying from one-fourth to one-half inch or more. The spots are light brown and superficial at first but later become nearly black and markedly sunken; the small black pycnidia (fruiting bodies) begin to appear within a few days after the blotch spot becomes visible. In stored apples, blotch takes the form of spots which show entire, not fringed margins, and are black in color from the first. On Ben Davis and Missouri and sometimes on other varieties cracks occur in the older spots which often intersect in the form of a cross or a "Y".

The disease occurs also on leaves, twigs and fruit spurs, the latter two being the source from which the infection spreads in the spring to the leaves and fruit.

Most of the damage to fruit occurs late in June, the particular time varying somewhat with the variety and with the weather during the growing season. Much of the diseased fruit drops before picking time but that which arrives on the market suffers seriously from blotch considered merely as a blemish and from rots due to secondary infection by the fungi causing black rot and blue mold rot.

The most susceptible varieties are Ben Davis, Missouri, Northwestern Greening, Limbertwig and Duchess. Winesap, Jonathan, York Imperial and Grimes are rarely affected. Blotch is most common and most destructive in Kansas, Arkansas and the southern portions of Missouri, Indiana and Illinois. It occurs, but is rarely very destructive in the East and has never been reported from the northwestern apple growing sections. On account of its regular occurrence in the sections named the disease is of considerable importance, in some seasons ranking with bitter rot and scab in destructiveness. On the market it causes more loss than bitter rot and less than scab. It develops and spreads very little if at all in transit or storage but the rots which sometimes follow it may do so if temperature conditions are favorable.

Blotch can be controlled by spraying three times at three-week intervals, beginning three weeks after the petals fall. In regions in which the disease has not been very destructive lime sulphur may be used for the first application and Bordeaux mixture for the latter ones, to avoid injury to the fruit. In severe cases, however, Bordeaux mixture should be used in all three. Spraying for blotch may well be combined with that for bitter rot.

APPLE BLUE MOLD ROT.

APPLE: BLUE MOLD ROT

Cause: A fungus (Penicillium expansum and probably other species of Penicillium).

This disease appears as soft watery spots of a light brown to pale straw color, which show all possible variations in size and may occur on any part of the apple. They are shallow at first but extend deeper very rapidly, in fact just about as rapidly as they increase in diameter externally. The superficial growth of blue or blue green mold which gives the rot its name may appear when the spot is small, or may not be developed until it becomes an inch or two in diameter, depending principally upon conditions of moisture and temperature. Under dry, cool conditions very little mold develops, even though the rot may progress quite rapidly; under warm moist conditions the superficial growth is almost sure to develop, usually in the small bunches or tufts characteristic of the species of Penicillium that most commonly causes this rot.

Infection seems to occur only where the skin has been broken in some way, whether by insects (grasshopper, codling moth larvae) other fungous diseases such as scab, by stem punctures, by hail injury or by careless handling methods in the orchard or on the market. The rot is common on summer or fall apples in barrels, following bruising caused when the head is forced in place.

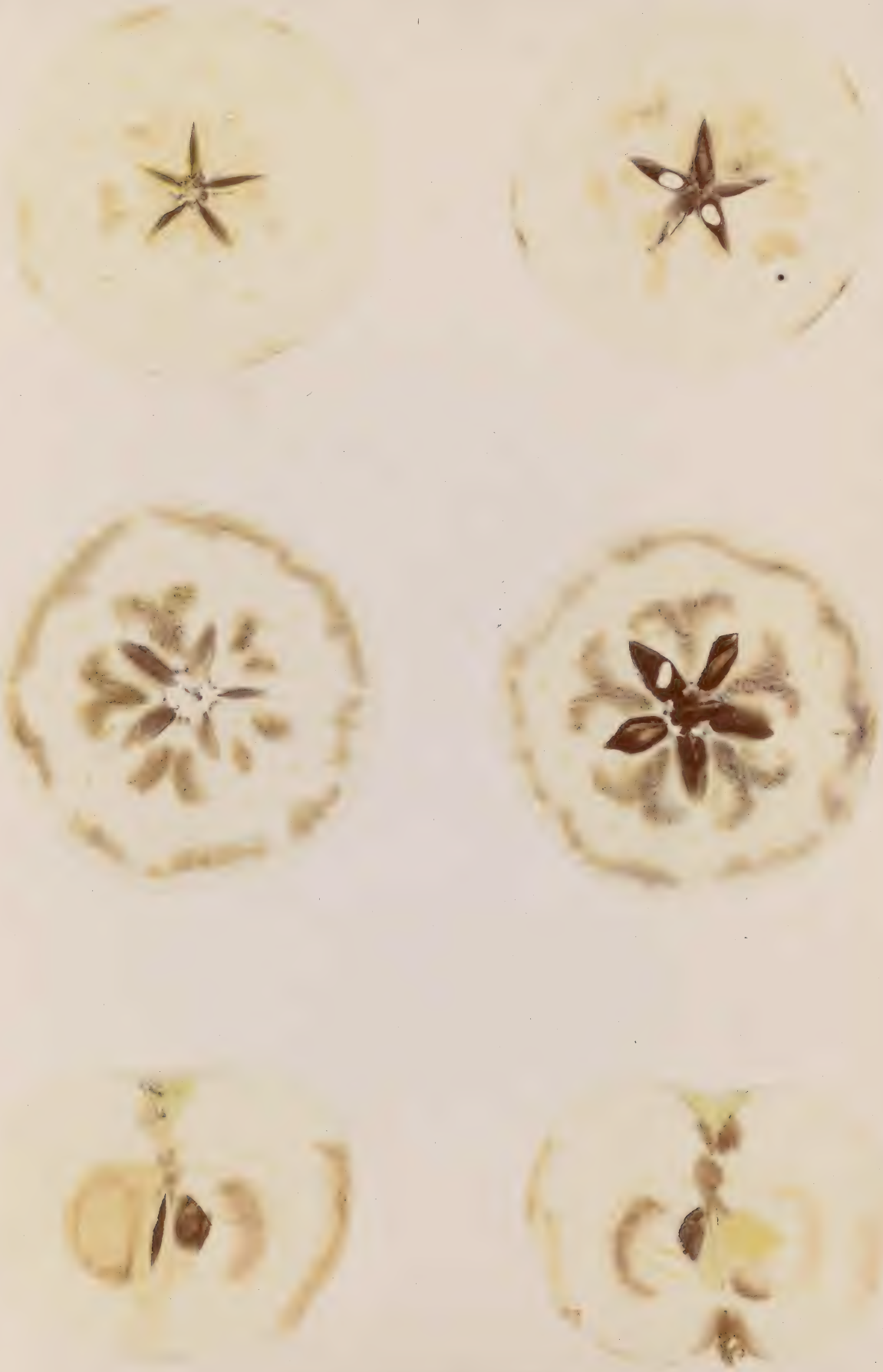
Blue mold rot is distinguished from all other soft rots of apple by the mushy, watery, light colored spots produced and by the blue-green tufts of spore-bearing mycelium mentioned above. The mold may sometimes appear on rotten areas that are much darker brown than the usual spots due to blue mold rot. In such cases it is practically certain that the rotten area is infected with blue mold and some other fungus such as pink mold or the black rot fungus.

Because of the manner in which infection takes place blue mold rot is common in all apple producing sections of the United States. In the Northwest it is common on dropped fruit in the orchard and in cull piles in or near packing houses and storage places, and is in fact, in many seasons,

the only serious rot with which growers in those sections have to contend.

It is more common on the market than any other apple rot and with the exception of scald probably causes more loss than all other apple diseases combined. It develops in transit or storage even on fruit under refrigeration but does not spread to unaffected fruits unless they have been injured mechanically, held at too low a temperature or held in storage too long.

Enough has been said about the manner of infection to indicate that the rot is to be controlled principally by careful handling of the fruit, throughout all the process of picking, packing and marketing. Infection, even of injured fruit, can be avoided to some extent by preventing the accumulation of rotten fruit in or near packing houses and cellar or warehouse store-rooms.



APPLE BROWN CORE.

APPLE: BROWN CORE.

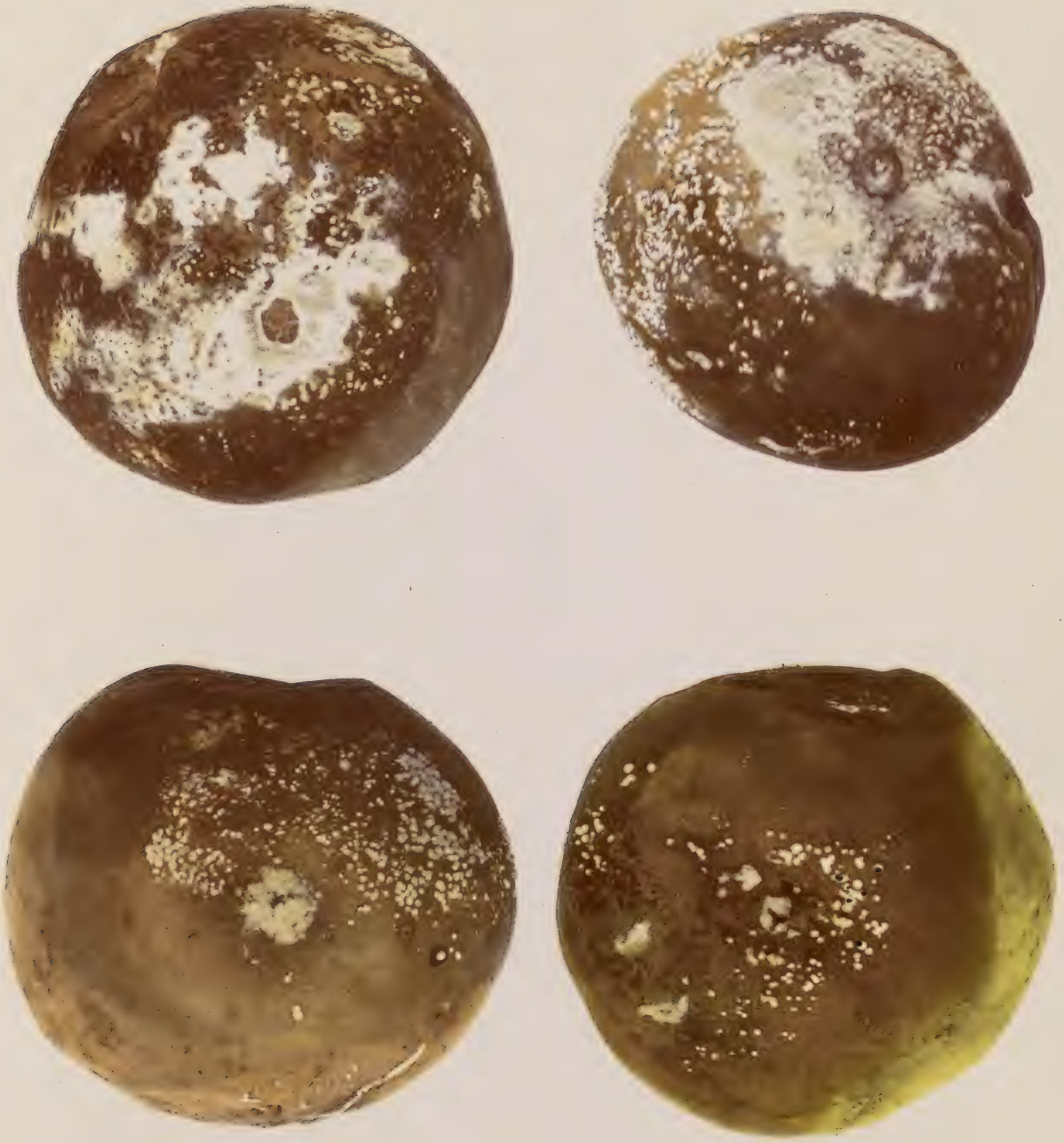
Cause: Unknown.

This rather uncommon apple disease is characterized by a marked browning close around the core, or, rarely, in regions just under the skin. The tissues may remain firm or they may break down with the formation of numerous small cavities but there is no decay and no order of decay. Nothing is known as to the cause of the disease except that it is non-parasitic. No fungi or bacteria have been found in the effected tissues.

Brown core is distinguished from core rot by the absence of decay and of any sign of fungus growth.

The disease is more common in California and the Northwest than in any other part of the country, occurring there almost exclusively on Yellow Newton, but is rare on the market.

Investigations at Watsonville, California have shown that the disease is not apparent at picking time develops after some months of storage. It seems to be worse, the lower the temperature at which fruit is held.



APPLE BROWN ROT. . .

APPLE: BROWN ROT.

Cause: A fungus (Sclerotinia cinerea).

This rot is caused by the same fungus that causes brown rot of peaches and other stone fruits. It often resembles black rot so closely that no positive diagnosis of either is possible without laboratory studies. There are some points of difference, however, which should be kept in mind. Apples in the early stages of brown rot frequently show black circular spots about one eighth of an inch across, scattered irregularly over the otherwise uniformly brown, rotted area. Each spot shows a lenticel (breathing pore) at its center. Apples in the early stages of black rot have either a solid reddish brown color or alternating zones of light and dark brown. As the two diseases develop, brown rot becomes darker, sometimes almost black all over and the characteristic gray fungus tufts appear; black rot becomes merely darker brown and shows numerous small black pycnidia (fruiting bodies) scattered irregularly over the rotted area. Apples affected with brown rot show some degree of blackening at an earlier stage than those affected with black rot, and shrivel sooner; in either case a black wrinkled mummy is the final result. Black rot is much firmer than brown rot; it is in fact the firmest of all apple rots.

The adjectives black and brown as applied to these rots are in many cases misleading. The inspector must, therefore, consider all of the symptoms noted above and not make a diagnosis of either disease merely because the color fits.

Brown rot attacks apples, pears and quinces and has been found on all of these in the regular inspection work. It occurs in practically all producing sections except those of California and the Northwest.

APPLE: CORE ROT.

Cause: Alternaria and other fungi.

Apples are sometimes found which, while sound so far as external appearance goes, are badly decayed at the core. The condition is generally due to infection with Alternaria or the black rot fungus following codling moth injury, or, less frequently, injury by the lesser apple worm. Core rot is sometimes due to infection following cracking at the blossom end, caused by dry weather late in the season.

The disease is not common in the orchard and is rarely found on the market.

APPLE SOOTY BLOTCH AND FLY SPECK

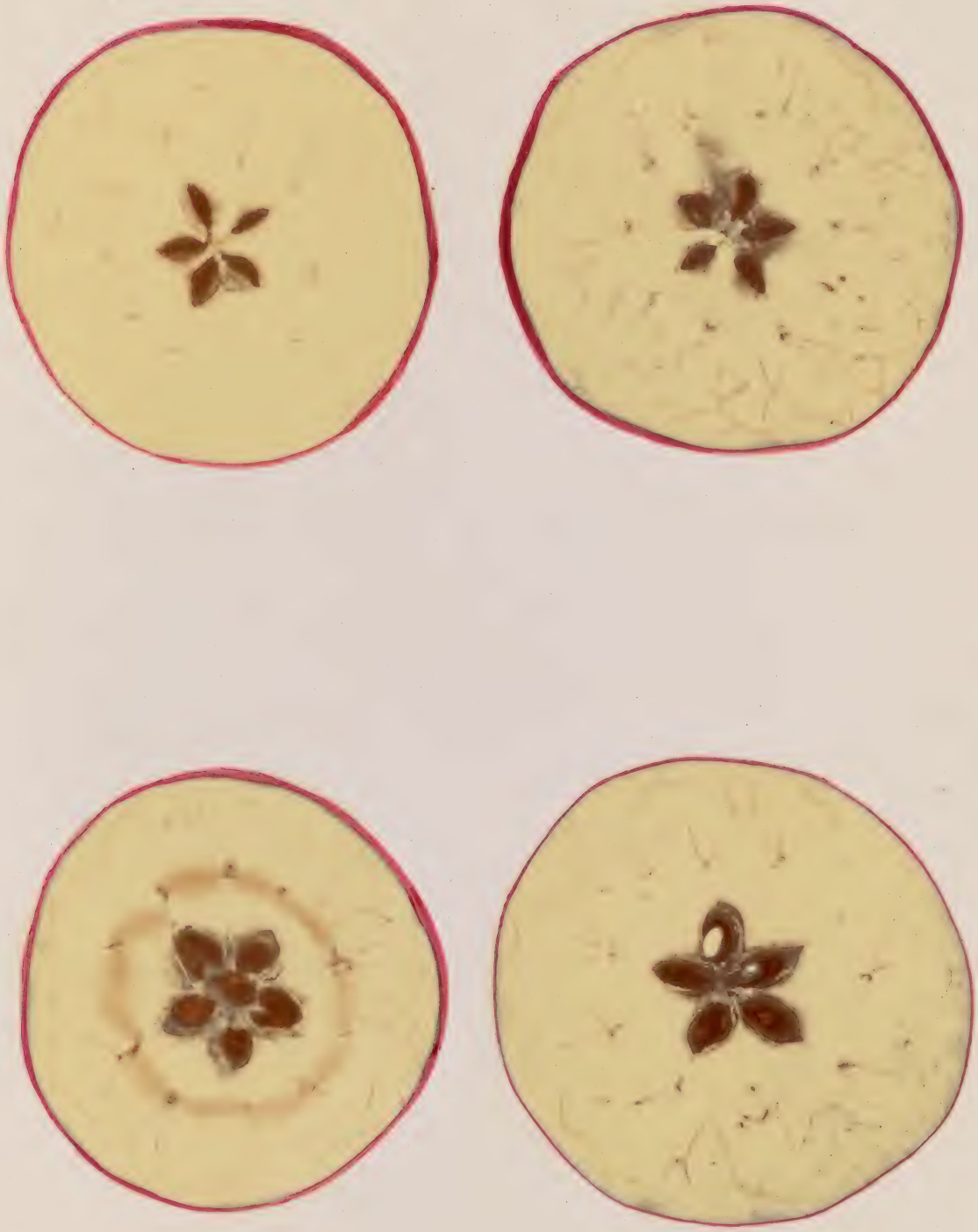
APPLE: FLY SPECK.

Cause: A fungus (Leptothyrium pomi).

This disease is well described by its name. The specks occur in groups over an area usually not more than half an inch in diameter and are as easily scraped off as sooty blotch. The two diseases are usually associated, but according to recent investigations, are caused by different fungi.

Flyspeck is of importance on the market only as a blemish. It can be controlled by the usual summer application of spray.

APPLE FREEZING INJURY



APPLE FREEZING INJURY.

37

APPLE: FREEZING INJURY.

Cause: Low temperature.

In considering freezing injury in apples or any other product it must be remembered that the amount and character of the injury depends on how low the temperature goes, on the rate of fall, on the length of time the fruit or vegetable is exposed to freezing temperature and possibly on the rate of thawing. And since it is not possible, under market conditions, to have very accurate knowledge of these various factors, any discussion of freezing injury from the market point of view must be limited largely to what has been observed under known conditions.

Well marked freezing injury on apples, such as usually follows exposure of the fruit to a temperature of 20 degrees F. or below for half a day or more, is characterized by a browning of some portion or all of the apple in such a manner that the water-conducting vessels (the fibrovascular bundles) stand out distinctly browner than the flesh around them. The skin appears brown and water-soaked and is often tough and leathery because of a thick layer of the flesh adhering to it. The flesh may be either dry and mealy or watery and mushy, depending on the severity of the freezing and possibly on other conditions not yet understood. When only part of the apple has been frozen the injured flesh is fairly well marked off from the uninjured but there is no such sharp line of separation as is often shown by frozen potatoes.

Apples showing the symptoms just described may be spoken of as frozen to death, since no matter how long they are held they do not recover their earlier healthy condition, in either texture or color, but continue to deteriorate. They are also rendered more susceptible to rotting by Rhizopus and blue mold.

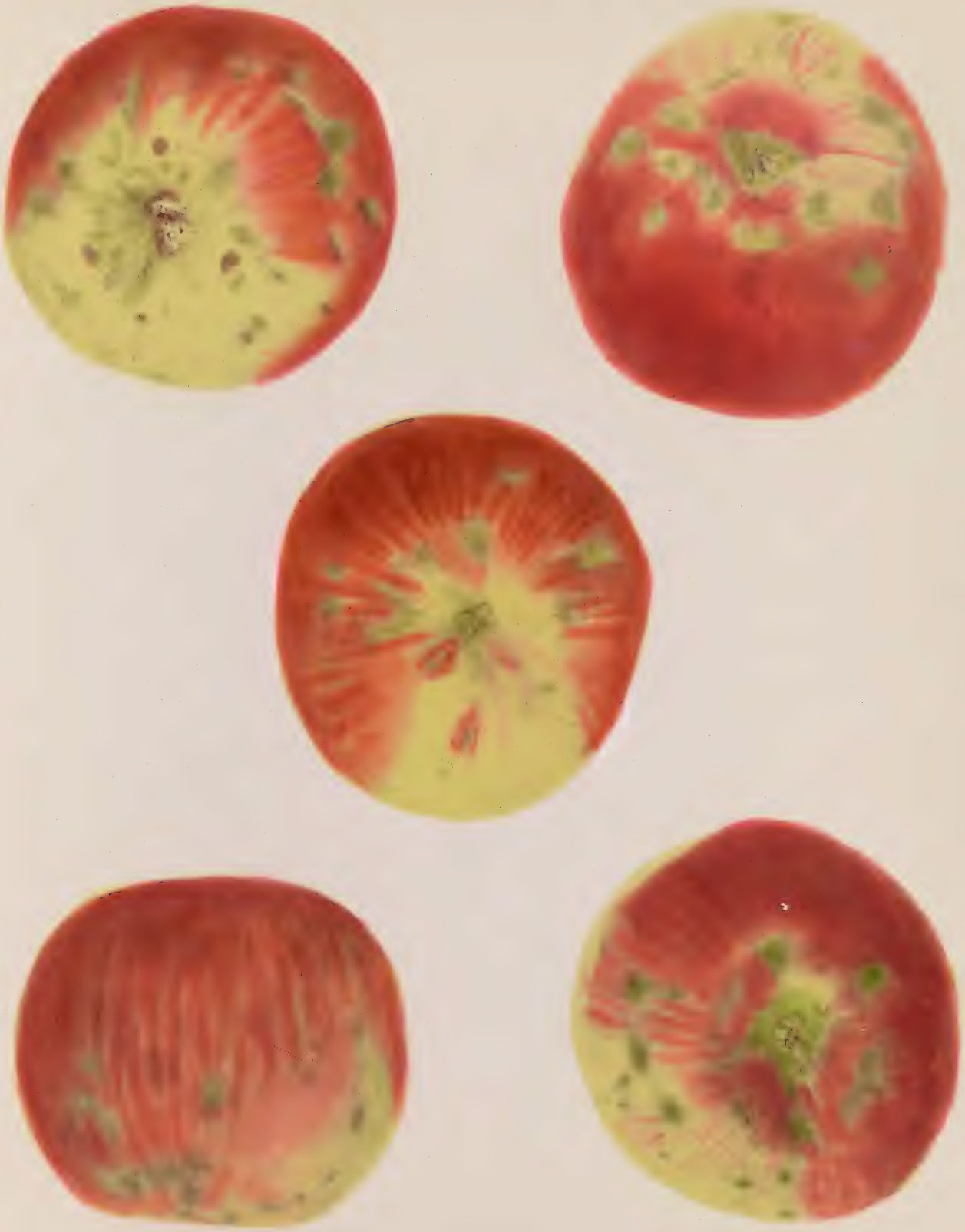
Apples may be frozen however and not frozen to death. This is shown by the fact that if they are frozen only slightly or frozen solid for only a short time they usually fail to show any browning and little else to indicate freezing injury beyond a premature mellowing and ripening. For reasons not yet known, the same condition is sometimes

shown by fruit exposed for several days to two or three weeks to temperatures ten degrees or more below freezing. It is obvious that in such cases no positive diagnosis of freezing injury can be made unless the fruit is found actually frozen.

The difficulty in diagnosing freezing injury from the symptoms here described arises from the fact that most of them may also be shown by apples which, because of immaturity or overmaturity at picking time, or from other causes, are affected by physiological breakdown - the so-called physiological decay. The only marked sign of freezing injury which such apples do not show is the watery, mushy condition of the flesh noted above.

Apples that have been bruised while frozen show brown spots underneath the bruises, even when no general browning has taken place. Such brown spots usually extend deeper into the flesh than those following bruising on non-frozen apples. When found on apples on the market even though the history of the fruit is not known they cn be taken as a fairly certain indication of freezing injury, especially if the bruised portion is watery and mushy and the skin covering it rather thick and leathery.

Apples which have been frozen but which show no marked browning are marketable and fit for food. Their keeping quality is impaired however and it is questionable whether they will hold up for any length of time in storage.



APPLE FRUIT SPOT

APPLE: FRUIT SPOT.

Cause: A fungus (Phoma pomi).

This disease is characterized by green to dark red spots occurring anywhere on the apple but most frequently and in greatest numbers on the blossom end. They vary from one-eighth to one-fourth of an inch in diameter and generally have a speckled appearance because of the presence of fruiting pustules of the fungus. The speckled appearance is quite marked on green spots but is more or less obscured on dark red ones. Small spots are usually only slightly sunken; larger ones may be so much so that the fruit is rough and misshapen. Whatever the color or degree of depression, the spots rarely extend more than a sixteenth of an inch into the fruit, the tissues beneath being green, or occasionally, brown and corky. On apples held till over-ripe the spots are often surrounded by a band of brown.

Because of their speckled appearance, fruit spots caused by Phoma are easily distinguished from bitter pit. They are further distinguished by being less abruptly sunken and by having no connection with the water-conducting system.

The disease occurs in Canada and has been reported from Germany. In the United States it is most common in the region east of Michigan and north of North Carolina and Tennessee, but is sometimes found as far west as Arkansas. It causes the greatest losses in New England, where 50 to 90 per cent of the fruit is affected in years when the disease is bad. Varieties most seriously affected are Baldwin, Tolman Sweet, and Yellow Bellflower. It sometimes occurs on Jonathan, Ben Davis, Arkansas, (Mammoth Black Twig), Grimes, Newtown Pippin and probably on others.

Fruit-spot is of importance on the market only because of the blemishing that results from it. It does not cause a rot nor is it often followed by rot-producing fungi. It does not develop or spread in storage and transit.

The disease usually can be controlled by two applications of Bordeaux mixture, one the last of June, the other late in July.

APPLE: GRAY MOLD ROT.

(See Grape: Gray mold rot).

APPLE INTERNAL BREAKDOWN

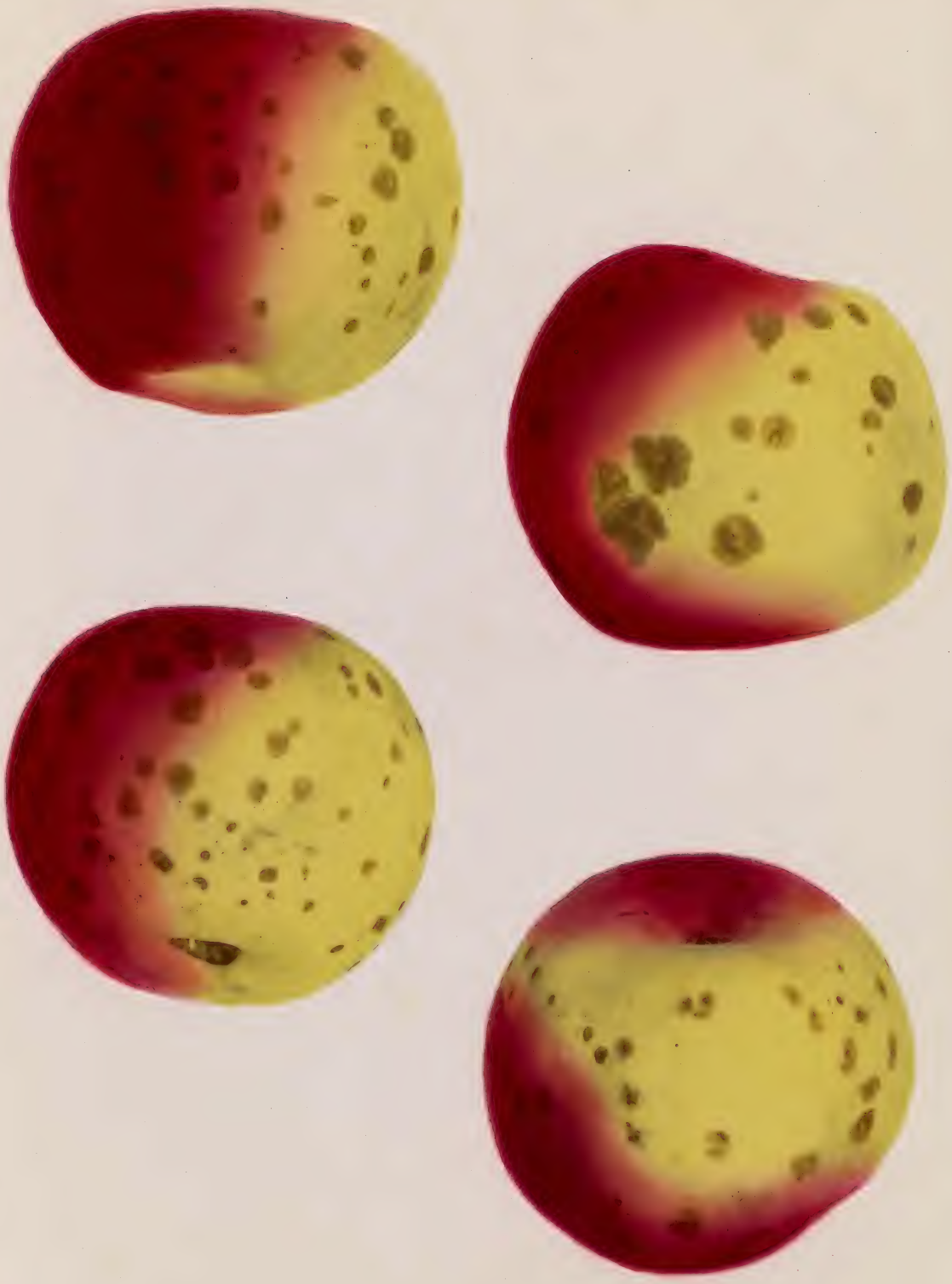
APPLE: INTERNAL BREAKDOWN

Cause: Picking at the wrong time, faulty storage conditions or freezing injury.

The symptoms of this disease are a mealy condition of the flesh and a browning which may be general or may be confined to the vascular bundles (the water-conducting system). Such conditions may be due to various causes but it is often difficult to say which particular one is concerned.

The browning and general breakdown may be due to overripeness, in apples that were picked too late, held too long out of storage, stored at too high a temperature or stored for too long a time. It may also be due to freezing injury, although in this case the flesh is often quite mushy and watery and shows a very pronounced browning, particularly in the water-conducting system. It should be remembered, however, that apples may be frozen solid and remain so for several days to two or three weeks without showing any browning when they thaw out.

Considerable loss occurs every year from internal browning in apples, much of which could be prevented by avoiding the conditions enumerated. More or less of it is probably inevitable on summer and fall varieties.



APPLE JONATHAN SPOT.

APPLE: JONATHAN SPOT.

Cause: Unknown.

Characteristic Jonathan spots appear as brown, roughly circular areas one-eighth to one-sixteenth of an inch in diameter which are abruptly but only slightly sunken and in early states confined to the color - bearing cells of the skin. Later the spots become somewhat more sunken and show as irregularly lobed, brown areas covering indefinitely limited masses of brown cells which extend down into the flesh for an eighth of an inch or more. In some cases decay follows this stage due to the entrance of Alternaria and possibly other rot fungi.

There is at present no evidence that Jonathan spot is caused by either fungi or bacteria; it is known to be more common after a dry season and in some years is more common on large apples than on small ones. It may develop in transit or storage, especially if temperature and humidity are high and ventilation poor. Experimental work by Brooks in the Northwest indicates that in cellar storage Jonathan apples picked early are more likely to show the spots than those picked late. These differences seem to largely disappear, however, if the apples are held in storage for two or three months.

Jonathan spot is distinguished from bitter pit by the fact that the spots are not deeply sunken, do not resemble bruises and bear no relation to the vascular system. They do not in any case resemble scald since they are definitely limited and small, while scald spots are usually large and not definitely limited.

The disease is rather widely distributed in the United States but seems not to occur in other parts of the world. It is of especial importance in New Jersey, Virginia, West Virginia, Illinois, Missouri, Arkansas, Washington and Oregon. The variety most commonly affected and on which the disease was first described is Jonathan; other varieties showing spots similar to but not quite identical with Jonathan spot are Esopus (Spitzenburg) Wealthy, Newtown, Grimes, Gravenstein, Ortley, Arkansas Black, Twenty Ounce Pippin and Wolf River.

The spots are of importance chiefly as a blemish, though occasionally decay occurs in connection with them as mentioned above. The most serious feature of the disease is its tendency to develop in transit or storage, resulting often in marked damage to the appearance of fruit which was in good condition when shipped or stored.

In the present state of our knowledge concerning the disease the following recommendations can be made for controlling it; the fruit should be picked when well matured but not overripe and placed at once in well ventilated cold storage having a temperature of 31 to 32 degrees F. Cellar or warehouse storage is very undesirable.

APPLE LEAF ROLLER INJURY

APPLE: LEAF ROLLER INJURY.

Cause: An insect (Archips argysophila).

In the form usually found on the market, this injury appears as russeted, slightly elevated spots which vary greatly in size but are not usually more than half an inch across. When the injury is severe, marked depressions or even deep clefts are formed which distort and disfigure the fruit. These, like the smaller spots, are russeted and may sometimes be quite rough.

The injury is caused by the larvae of a moth. These hatch in April or May, from eggs laid in June of the preceding year, as dirty yellow worms about one-twentieth of an inch long. At maturity they measure from nine-tenths to a little more than one inch in length. During most of their life they confine themselves to the leaves but when young they are sometimes found feeding in the buds. The injury which they cause there, while not as serious as that due to the bud moth, produces a cull in almost every instance.

Leaf roller injury may occur on apples from any of the large producing sections but so far as the markets work has shown, is most common on apples from the Northwest. Even on them it is rare since the grading rules define as a cull any specimen showing the injury.

Control methods recommended for the Northwest are, spraying with crude oil emulsion in the spring when the cluster buds are opening or with arsenate of lead just before the blossoms open.

APPLE LESSER APPLE WORM INJURY

APPLE: LESSER APPLE WORM INJURY.

Cause: The larva of a moth. (Enarmonia prunivora Walsh).

Injury of the lesser apple worm very closely resembles that of the codling moth. There are, however, certain differences in the character of injury of the two insects, and in most cases the work of the lesser apple worm can be recognized. Injury during spring and early summer is largely at the calyx end of the apple. Cavities or holes about one-fourth to one-half inch deep are eaten into the flesh more or less around the calyx lobes and the core within, the larvae entering through the skin at the base of the sepals, or directly in the calyx cavity. Much of the fruit thus injured falls or ripens prematurely and rarely finds its way into barrels at harvest time.

Later in the season injury by this insect to harvested fruit at the calyx end is about as described above. There is a tendency, however, on the part of the larvae to penetrate deep into the fruit, working often quite to the seeds. The proportion of surface injury, however, is now much greater, the larvae eating out just under the skin large, irregular, more or less winding, or blotch mines, which are quite conspicuous. This surface injury may occur in the calyx or stem basin, or on the sides of the fruit; in the latter case the skin of the apple is often broken, exposing the flesh beneath.

The work of the lesser apple worm is distinguished from that of the apple maggot by the fact that the skin and part of the flesh are actually eaten away; the apple maggot merely tunnels around under the skin but does not break it, except at the point of entrance.

The lesser apple worm occurs in practically all apple growing regions of the United States but the characteristic injury it causes is not often seen on the market. Only Yellow Newtown from California have been found injured by it, but doubtless many other varieties are effected.

It is likely to be found in apples in barrels to a greater extent than the codling moth. It is somewhat spindle-shaped and measures when full

grown about three-eighths of an inch in length,and is pinkish or whitish in color.

Under ordinary conditions the spray applied for codling moth will control the lesser apple worm.

APPLE: APPLE MAGGOT INJURY.

Cause: The larva of a fly (Rhagoletis pomonella).

The work of this insect is characterized by winding tunnels just under the skin and sometimes deep in the flesh of the apple. These tunnels vary in size but are usually about a sixteenth of an inch in diameter. They may occur on any part of the apple. Infection with blue mold rot and black rot often takes place.

The injury differs from that caused by the lesser apple worm in that the skin of the fruit is left uninjured except at the point of entrance. The lesser apple worm eats away the skin and a thin layer of flesh beneath it, and usually causes more extensive injury than the maggot.

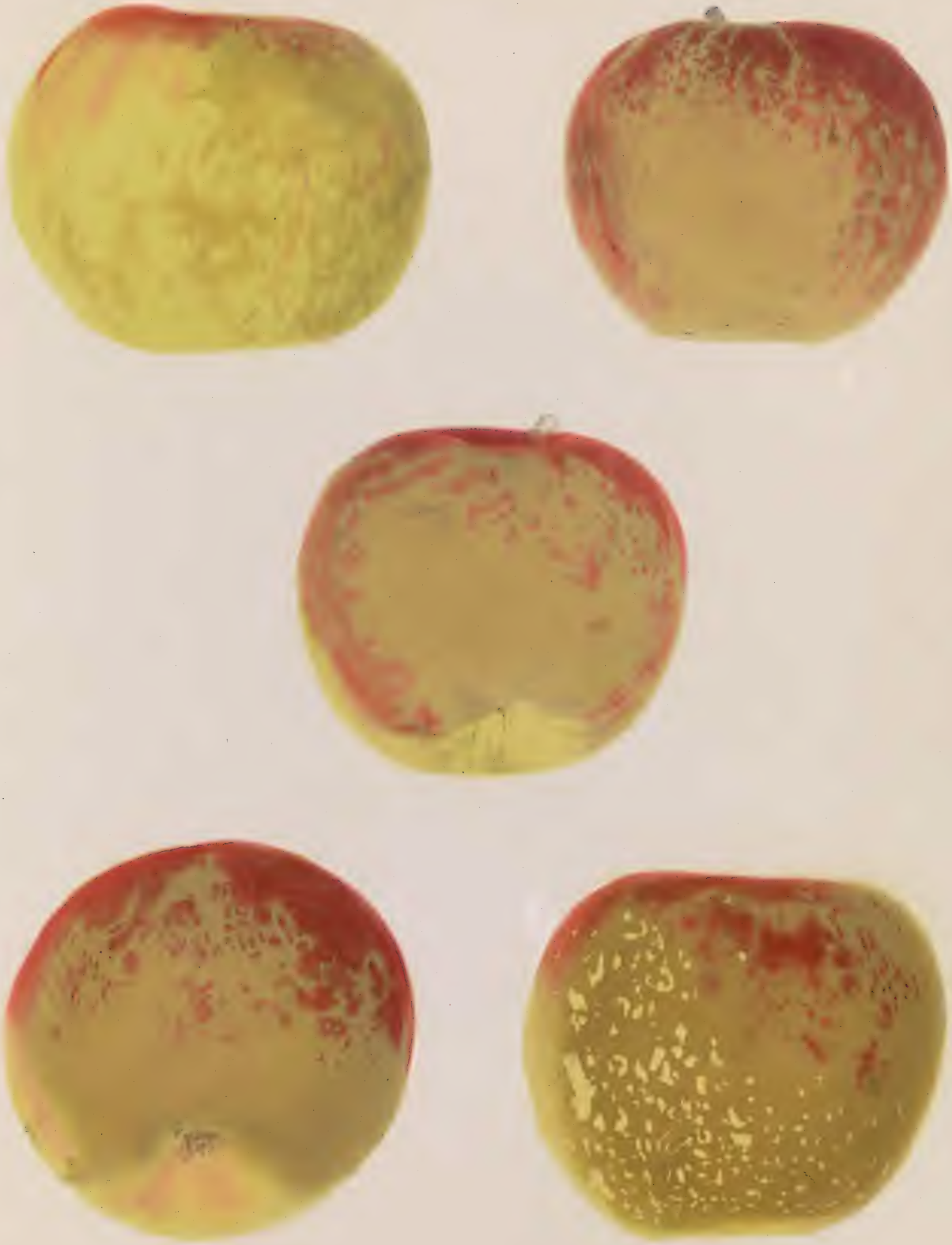
Apple maggot injury may occur on apples from any part of the United States but is not common on the market. It is severe in the North and Northeast, especially in New England.

Since much of the affected fruit comes to the ground as windfalls the collection and destruction of these will do much to control the pest. Frequent tillage to destroy the pupae is also effective. Spraying is of no value because the worm is always protected by the unbroken skin covering the tunnels.

APPLE PINK MOLD ROT FOLLOWING SCAB.

APPLE: PINK MOLD ROT.

(See Pear: Pink Mold Rot).



APPLE RUSSET

APPLE: RUSSET.

(See Apple: Spray injury).

APPLE RUST.

APPLE: RUST.

Cause: A fungus (Gymnosporangium Juniperi - virginianae).

Rust on apples in the market appears as yellow to greenish-yellow spots which vary in diameter from about one-eighth to three-fourths of an inch and bear on their surface small cup-shaped fruiting or spore-producing bodies. The spots generally occur at the blossom-end but are sometimes found on the side or at the stem-end. On cutting, the flesh beneath these spots is found to be greenish and rather woody but there is rarely any sign of rotting. Should this occur it is due to some other organism than the rust fungus.

The rust fungus belongs to a large group of parasites which require more than one host for completion of their life history - that is of all stages of their development. In the case of apple rust the second or alternate host is red cedar. The disease here appears as rough brownish galls known as cedar apples. From these it spreads in the spring to apple leaves and young fruits but must pass again to the cedar before it can complete its development.

Infection with rust takes place when the fruit is young but most of the damage done occurs when it is nearly grown, due to dwarfing and consequent reduction in quality. The disease occurs in practically all apple growing sections of the central and eastern United States.

Rust is of minor importance on the market. It occurs only rarely, and even then merely as a slight blemish, since badly marked fruit is usually culled out before shipment.

It will be seen, from what has been said about the manner of infection, that the disease can be controlled by removing all cedars in the neighborhood of an orchard. In practice it has been found necessary to extend the eradication to a distance of at least one mile. Spraying is much less effective, and is really of doubtful value.

APPLE SAN JOSÉ SCALE

APPLE: SAN JOSE SCALE.

Cause: An insect (Aspidiotus perniciosus).

This insect on apples appears as a gray to grayish brown scale less than a sixteenth of an inch in diameter, usually surrounded by a red ring. The insect itself is under this scale. Occasionally a very small black stage, known as "nigger" scale is found.

The scales and the insects they cover are easily rubbed off and when this is done there is exposed a light colored spot inside of a red ring. A spot suggesting scale, even to the red ring, is often found at places where some rot infection is just beginning, but in this case the center of the spot is brown or black and cannot be rubbed off.

APPLE SCAB.

APPLE: SCAB.

Cause: A fungus (Venturia inaequalis).

Scab on apples in the market shows as irregular circular spots one-eighth to one-half inch in diameter which have either a dark green to nearly black, velvety surface, or a brown, russeted, rough surface with merely a fringe of dark green around the margin. The difference between the two is due partly to difference in age - the velvety spots being the younger - or to a rubbing off of the dark colored material (fungus threads and spores) during the processes of picking and packing. Spots typically dark green and velvety generally show a ragged papery fringe of cuticle which has been loosened from the tissues beneath by the growth of the fungus. The spots are usually thickest about the blossom end and in cases of severe infection may coalesce to form large irregular lesions an inch or more across. Badly diseased fruits are often misshapen because of dwarfing on the side where infection occurs. Scab spots which have developed in storage are generally small, darker than the common type, and smooth, since the fungus does not break through the cuticle. Such spots, on account of their color, are sometimes confused with blotch. They can be distinguished from it by the fact that no fruiting bodies are developed and by the further fact that the cuticle covering the spots is not broken. The edges of such spots never show the marked feathery fringed appearance characteristic of the early stages of scab.

Scab may occur on apples at any stage of their development but naturally is most serious in the latter part of the season when the spots become large. It occurs in all apple growing sections of the United States but is most destructive in the cooler regions of the eastern states, the upper Mississippi Valley, the Northern Pacific Coast states, the apple growing sections of Idaho and Montana and in the mountainous portions of Virginia, Arkansas and other southern states. In the northern United States it is the most destructive of all apple diseases. Farther south the losses caused by scab are often exceeded by those caused

by blotch and bitter rot. Hesler and Whetzel estimate the annual loss for New York state from scab at three million dollars and for the United States at forty million dollars.

The disease does not develop or spread to any marked extent in transit but may develop in storage (storage scab) if late infection has occurred in the orchard. On apples from the northern and northeastern states it is often followed by pink mold rot, which develops both in storage and in transit.

Under ordinary conditions scab can be controlled by spraying with lime sulphur solution (1) as soon as the cluster buds have separated but before the blossoms open, (2) just after the petals fall, (3) ten days or two weeks after the second application, (4) late in July or early in August.

APPLE SCALD

APPLE: SCALD.

Cause: Faulty storage conditions and storage of immature fruit.

Apple scald is a storage and transportation disease. In mild cases the skin of the fruit is merely browned, in severe ones the whole epidermal tissue may be killed. If in the latter condition it sloughs off readily from the remainder of the apple. In some cases the flesh becomes dead and brown to a depth of one-eighth to one-half an inch and has much the appearance of a rot. True rot lesions, however, usually spread down into the flesh in more or less conical shape while those of scald are diffuse. They have a larger area than rots but less depth. Scald is usually confined to the greener side of the apple.

Deeply colored skin areas are very rarely affected. The disease is caused by gases given off by the apples themselves. Or, stated in another way, it is not necessarily an old age phenomenon but is due to the long-continued action of more or less abnormal storage conditions that cause the production or prevent the elimination of harmful waste products. It is not caused by accumulation of carbon dioxide nor by high humidity.

The disease is worse on immature than on mature apples and worse on apples from heavily irrigated trees than on those receiving more moderate irrigation. It develops more and more rapidly as the temperature rises, up to 59 to 68 degrees F., the optimum often shifting from 68 to 59 degrees F. during the storage period. It seldom if ever becomes evident while apples are held continuously at 32 degrees F. but may appear within a few days if cold-storage apples are removed to a higher temperature.

Under present storage conditions scald occurs on apples from all producing sections of the country. No variety is absolutely immune but some are more commonly and more seriously affected than others. Among the more susceptible varieties are Arkansas (Mammoth Black Twig) Rome, Wagener, Baldwin, Rhode Island Greening, Huntsman, Grimes, Winesap, York Imperial, Gano, Black Ben Davis and Ben Davis.

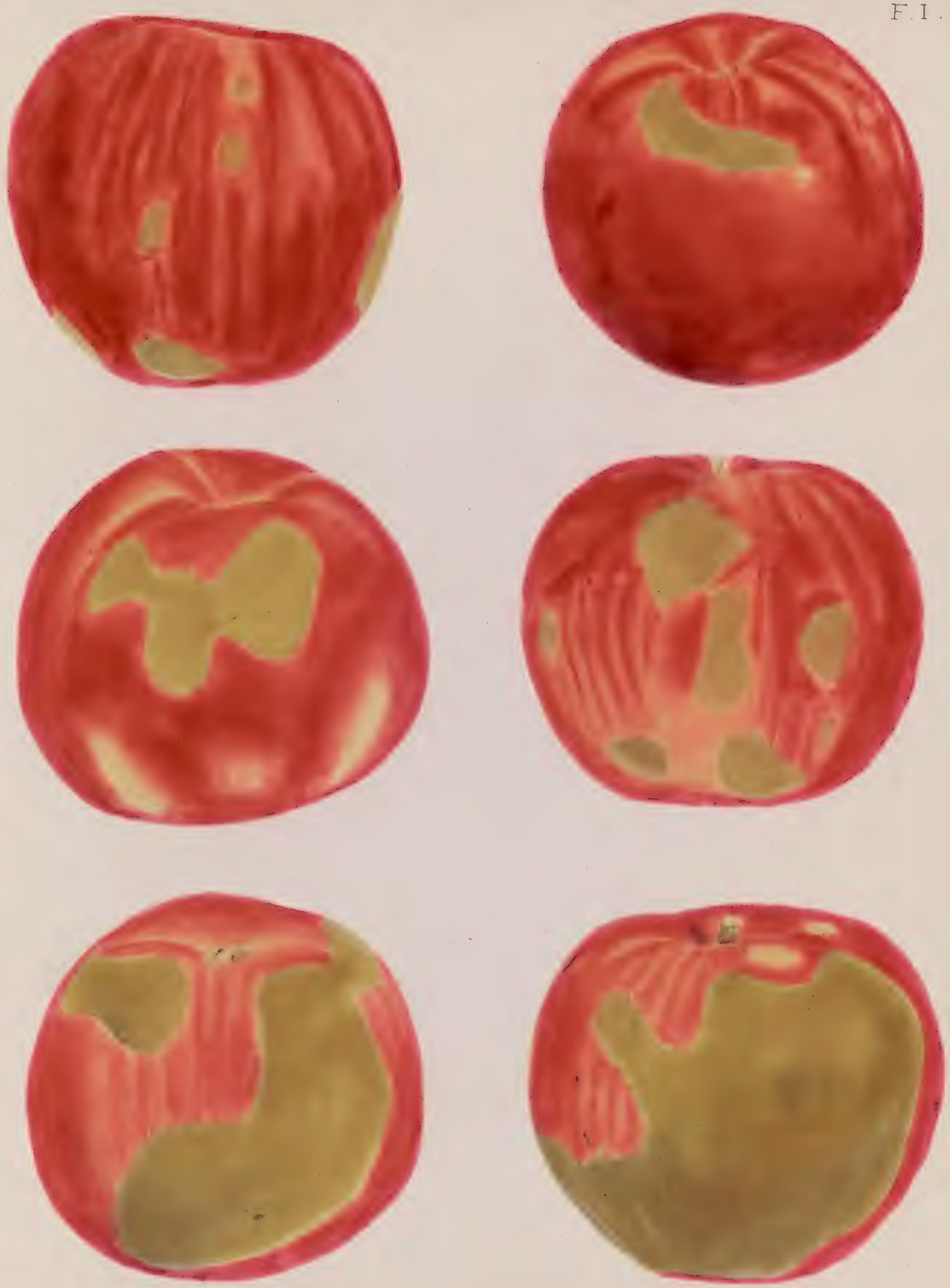
Careful experimental work has shown that scald can be prevented by ventilation of storage places and by the use of containers which allow free circulation of air, especially if the storage room is ventilated occasionally. It can be prevented also by the use of wrappers soaked in oil or fat. The value of ventilation or of impregnated wrappers lies, of course, in the fact that the scald-producing gases are removed from around the apples. Scald can be reduced on immature apples by a delay before storage if the fruit is kept well aerated during the delay. It is increased by the delay if there is little or no ventilation. Delay under unfavorable conditions greatly shortens the storage life of the apple.

The length of time for safe storage of apples varies with the variety, with the efficiency of the refrigeration, with the maturity of the fruit when stored, and possibly also with the section of the country or kind of soil where the apples were grown. For these reasons it is difficult to set any hard and fast rules. Under conditions now existing in commercial cold storage houses the latest dates for withdrawal from storage for the important commercial varieties are about as follows:

Grimes	December 15.
Jonathan & McIntosh	January 15.
King David and Huntsman	February 1.
Gano and Esopus	February 15.
Northern Spy	Feb. 15-April 15.
(York, Rhode Island (Greening, Rome (Ben Davis (Arkansas Stayman (Baldwin	March 1 - March 15.
(Yellow Newtown (Winesap (Tompkins King	April 15.
(Baldwin (Arkansas (Arkansas Black	May 1-15.

If the recommendations for control outlined above were followed, the storage period for all of these varieties could undoubtedly be lengthened.

Scald causes greater losses that any other disease of apples. Under present day storage conditions it is safe to say than any variety held in storage later than the first of May is practically certain to show scald after removal if not before, and that there is, every year, a heavy loss on apples so held.



APPLE SOFT SCALD

APPLE: SOFT SCALD.

Cause: Unknown.

Soft scald is of rather uncommon and sporadic occurrence. Jonathan and Rome Beauty are the most susceptible varieties though Grimes is sometimes affected. The disease is characterized by peculiar patches and ribbons of watery brown tissue on the surface of the apple. The tissue is usually killed to a depth of one-eighth to one-half inch. There is a clear cut margin between the living and the dead tissue and the affected areas do not appear to increase in size. The cause of the disease is not known.

APPLE: SOOTY BLOTCH.

Cause: A fungus (Gloeodes pomigena).

This disease is marked by sooty patches or spots, very irregular in size and shape, which may occur on any part of the apple. They are easily removed by scraping with the finger nail or a knife blade or by moistening and wiping the apple. On Kieffer pears the blotches are often surrounded by a zone of russet.

The disease causes no decay nor even a browning of tissues under the spots but affected fruits are sometimes badly wilted. The chief loss is due to blemishing by the fungus and consequent reduction in the market value of the fruit.

Sooty blotch is common throughout the central, eastern, and northeastern apple growing regions of the United States but is rare in the Northwest. All late summer and winter varieties may be effected by it.

The disease is of minor importance on the market. It does not develop or spread appreciably in transit or storage. It is easily controlled by the usual summer applications of spray.

APPLE LIME SULPHUR SPRAY INJURY

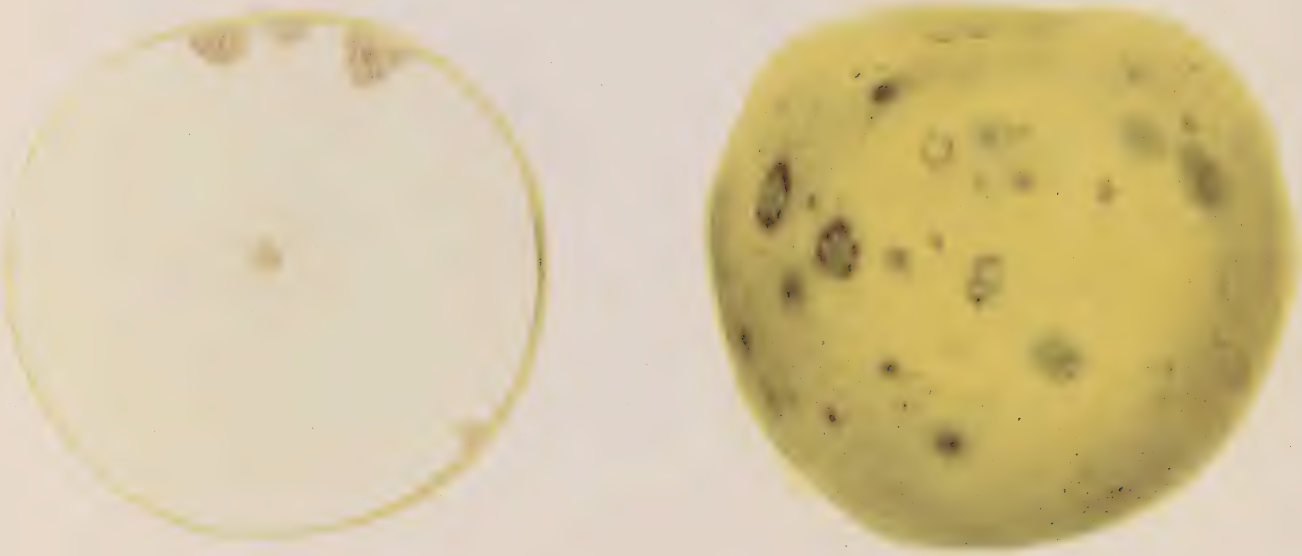
APPLE: SPRAY INJURY.

Cause: Spray chemicals.

Bordeaux mixture. The commonest form of this injury is characterized by a roughening or russeting of the skin, usually confined to one side of the fruit, because of the manner in which the spray is applied. In bad cases the fruit may be deformed by a pronounced knob or swelling on the injured side. Injury of this kind is likely to occur if the mixture is used too strong, or too early in the season, or is put on in such a way as to drench the fruit. Occasionally, late applications may cause injury in the form of small red or purple pimples, especially on green or yellow varieties such as Yellow Newtown (Albemarle Pippin).

Lime-sulphur. Injury by this compound generally appears as hard brown or black, sunken areas which vary in diameter from half an inch to an inch or more. Badly injured fruits sometimes crack around the spots and become infected with various rot fungi. This is most common on fruit sprayed with lime-sulphur early in the season. Ben Davis is especially susceptible.

Another form of injury sometimes found, occurs in the blossom-end of the fruit, close around the calyx. It is known in some sections as lead injury or arsenical injury but is caused either by the fungicide (Bordeaux mixture or lime-sulphur) or by combined action of fungicide and arsenate of lead. It usually appears as a dry, black, sunken ring which has cracked away slightly from the uninjured skin around it. On Ben Davis, Jonathan, Ingram (the most commonly affected varieties) it furnishes a place of entry for the black rot fungus and the production of a decay often known as blossom-end rot.



(above) APPLE HONEY APHIS INJURY
(below) APPLE STIGMONOSE

APPLE: STIGMONOSE.

Cause: Injury by insects.

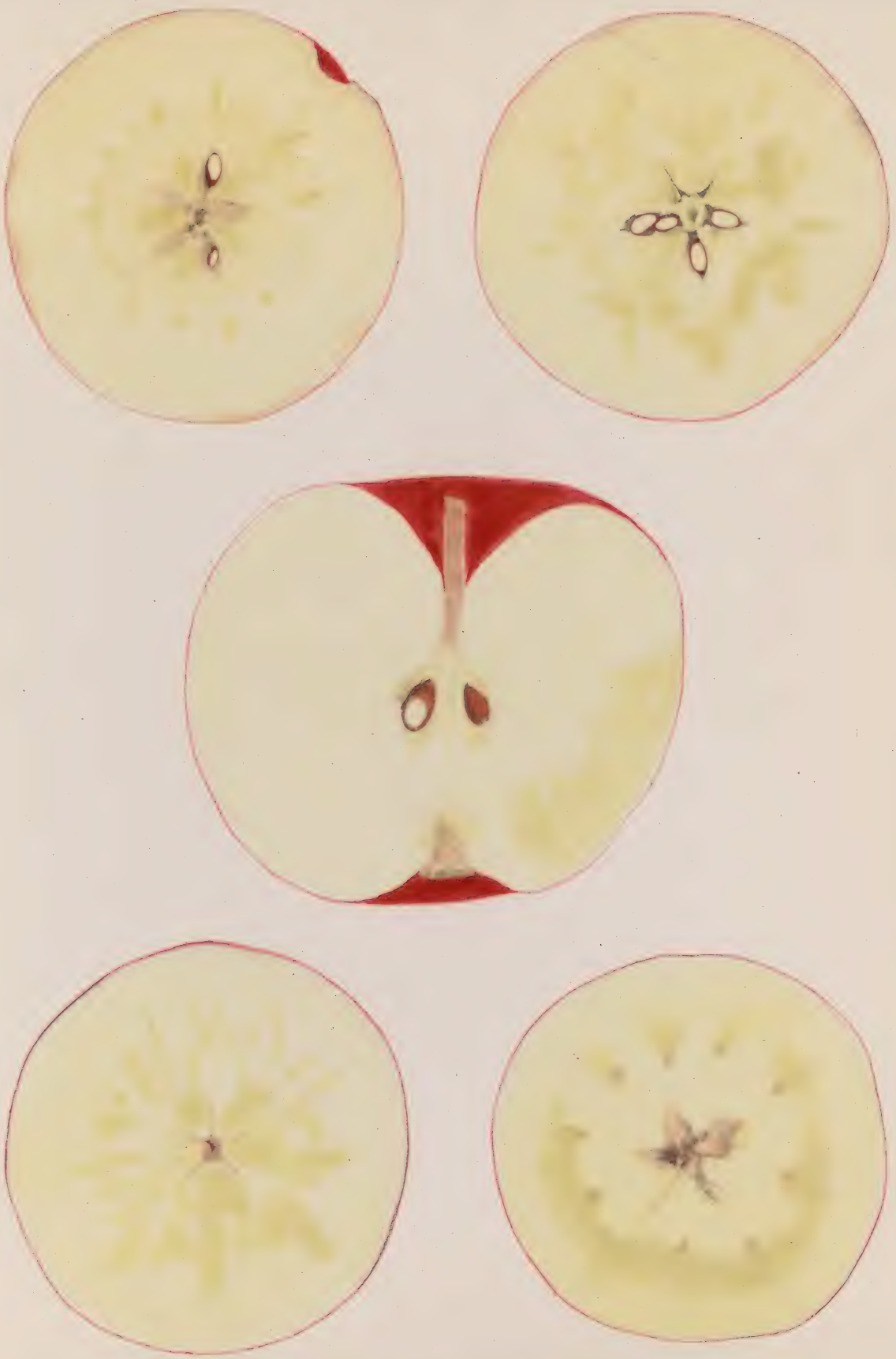
The commonest form, caused by rosy aphis, is characterized by numerous small, slightly depressed spots which have a lighter or darker color than the surrounding skin and beneath which can be found small, roughly spherical masses of corky brown tissue. Badly affected fruits have a knobby, uneven surface. The injury bears some resemblance to bitter pit but can be distinguished from it by the fact that the brown masses underneath the spots are generally darker brown and larger than those found in bitter pit. Furthermore, they are always near the surface, while bitter pit spots may be either near the surface or deep within the flesh and in either case are closely connected with the water-conducting system of the apple.

The apple maggot or railroad worm may cause the apple to develop numerous small red or brown spots and an uneven irregular surface. Upon cutting into the apple small canals, less than a sixteenth of an inch in diameter, may be found spreading deep into the flesh.

Plant bug punctures cause distinct depressions on the surface of the apple and large spots of hard corky tissue in the flesh.

These injuries are rare on the market and when they do occur are of importance only because of the blemishing they cause.

No control is known for the plant bug. Rosy aphis and railroad worm can be controlled by spraying.



APPLE WATER CORE

APPLE: WATER-CORE.

Cause: Non-parasitic. Probably a disturbed water-relation.

Clear, hard, water-soaked regions in the flesh of the apple characterize this disease. These regions may be at the core,as indicated by the name, or around the core lines (the main branches of the water-conducting system) or even in the outer portions of the apple. Only in the latter case is the disease visible without cutting.

It is possible at times to detect a sweetish fermented odor and a taste resembling that of frozen fruit but usually only the normal taste and odor are present. In badly affected specimens there is often a browning of the surrounding tissues, especially the vascular bundles (branches of the water-conducting system), such as is seen in overripe fruit that has been frozen. Whether this condition is due to the same causes that produce water-core is not known.

The appearance described for water-core is due to an excess of water in the affected tissues but how this excess is brought about is not known. At the present time it seems certain that neither fungi, bacteria, or insects have anything to do with it. The general belief is that water- core results from a checking of transpiration (the giving off of water by the leaves) and the consequent forcing of water into the spaces between the cells in certain portions of the fruit. If this be the true explanation it is easy to see why water-core usually is closely related to the water conducting system.

Some of the conditions which have been found to induce water-core are: (1) vigor in trees, resulting in excessive growth, especially in young trees just coming into bearing; (2) excessive water supply, whether from irrigation or rainfall, especially when following a period of scanty supply; (3) reduction in leaf surface by drought, by fungus or insect injury, or by heavy pruning.

Apples which have been bruised while frozen sometimes show soft, water-soaked regions around the tissues injured by freezing but the relation between the two is usually so clear that there is

no mistaking it. When true water-core occurs in the same fruit with freezing injury it can generally be distinguished from the condition just described by its location and its firm texture.

Water-core occurs in most of the apple growing regions of the world. It is found in practically all apple sections of the United States but is of greatest importance in those having an arid or semi-arid climate. Susceptible varieties are Early Harvest, Yellow Transparent, Pound Sweet, Rambo, Tompkins King, Jonathan and Winesap. The latter variety, in the Northwest, is more often affected than any other and more likely than any other to show the disease in amounts great enough to be of importance on the market. Outside of the Northwest the disease is rarely of commercial importance on any variety.

Because of its non-parasitic nature, water-core does not develop or spread in storage or transit. In mild cases it may and often does disappear after the fruit has been stored for a few months. So well is this known to the trade that little objection is made to apples only slightly affected with the disease.

Since water-core is so closely connected with climatological conditions, complete control is not possible. Fairly good results can be obtained, however, by providing proper drainage if the natural drainage is poor, by keeping the orchard well sprayed and cultivated, and by avoiding heavy pruning at or just before the ripening period. Pruning should not be done just before picking time. Fruit should be picked when well matured but not overripe and should be stored immediately.

APRICOT PUSTULAR SPOT.

APRICOT: PUSTULAR SPOT.

Cause: A fungus (Coryneum).

This fungus causes, on the fruit, a small, brown corky pimple or pustule. The size of the pustules varies considerably, from one-sixteenth to one-eighth of an inch in diameter. Sometimes several of them coalesce forming a scab which may be one-fourth of an inch or more in diameter. There is also a similar disease which seems to be caused by physiological factors. However, where inspections are made, any disease fitting the description here given should be called pustular spot. In order to distinguish between the two diseases, cultures must be made from the diseased areas.

This disease is confined to apricots from California. It causes a great deal of loss to the grower in that it dwarfs much of the fruit and causes the rest to be sold as second or third grade. Badly affected apricots are dried, instead of being shipped to market, or they may be canned.

The disease does not spread in transit. Diseased fruits were infected before they left the field.

Pustular spot can be controlled by the use of lime sulphur sprays in the orchard.

BANANA ANTHRACNOSE.

BANANA: ANTHRACNOSE.

Cause: A fungus (Glomerella musae).

The disease first makes its appearance as small circular brown spots, varying in diameter from one-thirty second to one-sixteenth of an inch. As the disease progresses these spots coalesce to form areas an inch or more in diameter which may continue to enlarge until the whole banana is blackened. At this stage or even earlier the blackened areas begin to show pink spots, due to the formation of the pink spores (in masses known as acervuli). The spores are enveloped and held together by mucilage, hence are easily transferred from one banana to another during the process of handling.

The disease is prevalent in the field but does very little damage to the bananas until they are ripe. It works rapidly in the ripening rooms, which are kept moist and warm. It also causes a great deal of decay and waste, in warm weather, outside of the ripening rooms, wherever bananas are stored or exposed for sale. Many of the so-called overripe bananas are merely in an advanced stage of decay caused by the fungus.

There is no doubt but that a great deal of the loss due to anthracnose could be prevented if the ripening rooms were cleaned out often and washed down with some disinfectant. The practice of putting hay or sawdust on the floor is especially pernicious, for such material certainly becomes contaminated with the banana refuse and passes the disease on to healthy fruit.

BLACKBERRY BLUE MOLD ROT.

BLACKBERRY: BLUE MOLD ROT.

(See Orange: Blue mold rot).

CHERRY BROWN ROT.

CHERRY: BROWN ROT.

(See Peach: Brown rot).

CHERRY RHIZOPUS ROT
AND BLUE MOLD ROT.

CHERRY: RHIZOPUS ROT AND BLUE MOLD ROT.

(See Strawberry: Rhizopus rot and
Orange: Blue mold rot).

ORANGE BLUE MOLD ROT.

BLUE MOLD ROT.

Cause: Fungi (Penicillium sp.).

Under the term blue mold are included several different species of the fungus Penicillium, one of which has a greenish or greenish-blue color and in the trade goes by the name of blue mold. Nearly all kinds of fruits are attacked but the greatest losses occur in citrus fruits and apples. Blue mold rot of the latter is discussed under a separate heading.

Much of what is said there and in the statement given below on blue mold rot of citrus fruits is true for the rot as it occurs on other fruits. It can always be distinguished by the green or greenish-blue color of the spores, and by the failure to produce an extensive growth of mycelium. It is not as leaky as Rhizopus rot and it produces in affected fruit, not a sour but only a musty odor.

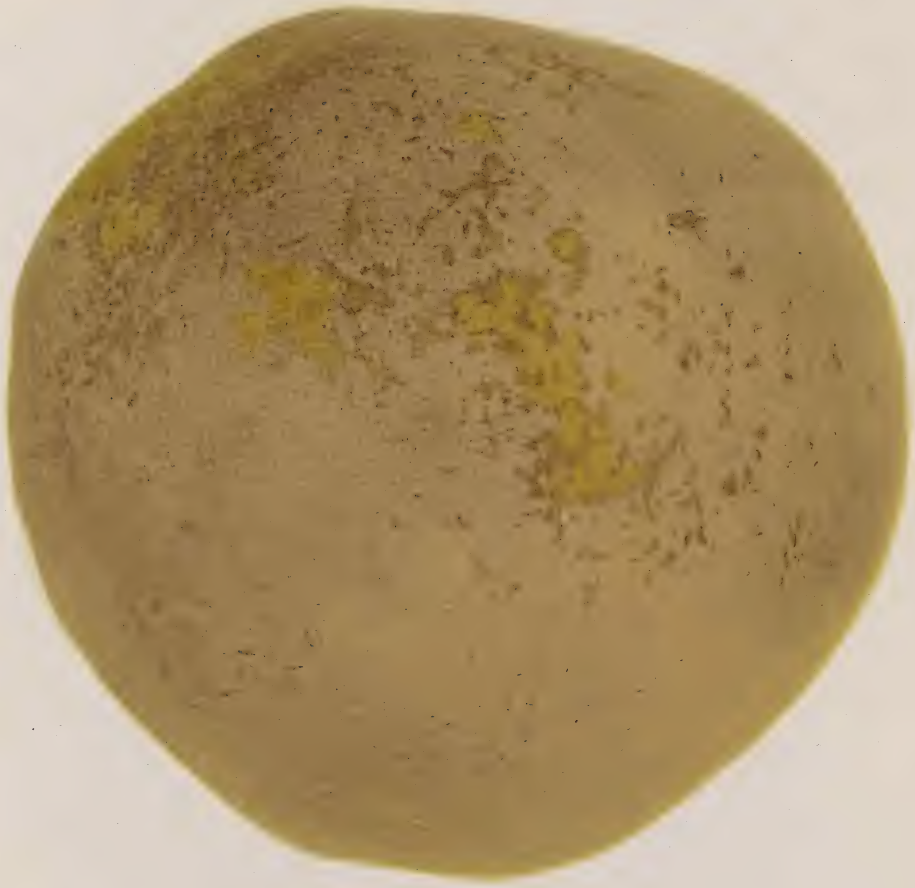
In the case of citrus fruits the disease shows first as a small watery spot, the so-called pinhole stage; the spot enlarges rapidly and soon reaches what is known as the blister stage and finally passes over into the blue mold stage in which the fungus appears on the outside of the fruit as small tufts which are white at first but which later become green or greenish-blue, due to the production of great numbers of spores. All three of these stages are, of course, due to the same fungus.

The spores of blue mold are very small; for this reason, the least draft of air or any mechanical disturbance will agitate them so that they are scattered in all directions. Oranges, lemons and grapefruit are often repacked to remove fruit rotted by blue mold but if this is not done carefully there is always a chance of spreading the disease still further. The spores may be carried from moldy fruit to sound fruit by the hands of the workman or they may be carried by air currents from the refuse barrel where the affected fruit is thrown.

Blue mold is present everywhere but is unable to attack the fruit unless the skin has been broken in some way. This occurs most commonly through carelessness in handling during the pick-

ing and packing processes and is responsible for much of the loss fron blue mold in citrus fruits. Since the spore is about one-thousandth of an inch in diameter it is readily seen that a wound need not be much larger, to admit it. This means that wounds too small to be visible to the unaided eye are still large enough to be dangerous where blue mold is concerned. After the spore has fallen on a suitable medium, i.e. a wound in the skin of the fruit, it begins to germinate. The fungus then ramifies through the fruit, breaking down the tissues and causing decay.

Once established in the fruit the fungus will grow at very low temperatures. Therefore the method of control is careful handling combined with sanitary condition of the packing houses. If, however, the cars have been properly iced during transit, the fruit will arrive in good condition even though it may have been injured in handling, provided it was not infected with blue mold when loaded in the car. On the other hand if the cars have not had proper icing the blue mold is not kept in check and the fruit is lost.



GRAPEFRUIT BUCKSKIN.

GRAPEFRUIT: BUCKSKIN.

Cause: Unknown.

Fruits affected with this disease have practically the entire surface of the rind slightly roughened and of a grayish appearance. The rind becomes abnormally thick. Young fruit is often stunted in growth; fruit of normal size is commonly light in weight and contains less than the usual amount of juice. Buckskin is much lighter in color than either melanose or russeting due to rust mites.

The disease is thought to be due to injury by rust mites when the fruit is small, aggravated and extended by a surface growing fungus which follows the work of the mites. It is usually found more abundant toward the center of the tree.

Though the disease does not spread in transit the damage done by it is considerable, since much of what would otherwise be classed as "bright" fruit must be placed in the russet grade.

GRAPEFRUIT MELANOSE

GRAPEFRUIT: MELANOSE

Cause: A fungus (Phomopsis citri).

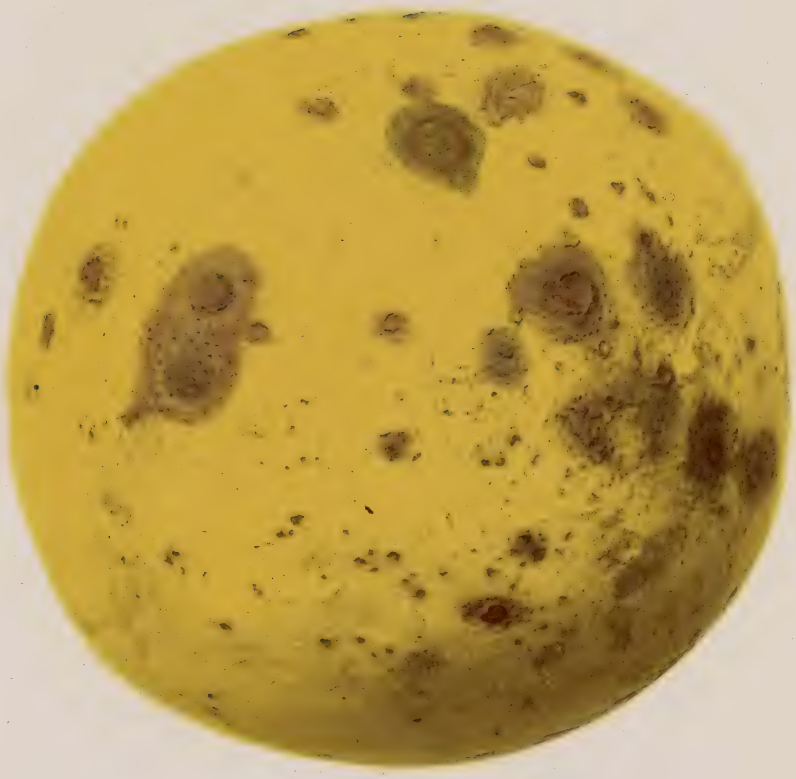
This disease occurs in Florida, on the leaves, young twigs and fruits of both grapefruit and oranges. It can be recognized on the fruit as small, brown, raised spots (produced by the fungus attacking and killing a few epidermal cells of the rind). Generally the individual spots are about the size of a pin head although they may coalesce to form rather large scab-like patches. Sometimes the dots are so arranged that they resemble tear staining but can readily be distinguished from it on account of their brown glazed appearance.

The fungus causing this disease lives in the dead wood on the tree. During rains the spores are washed down onto the fruit where they germinate readily in the presence of sufficient moisture and produce the disease. No spores are produced on the fruit.

Melanose is of importance merely as a blemish. It does not develop into a rot. Severely infected fruits are shipped as russets, those more lightly infected as goldens.

Melanose originates in the field but since no spores are produced on the fruit the disease cannot spread in transit.

Control depends upon proper spraying and the removal of diseased wood from the tree.



GRAPE FRIUT NAIL HEAD RUST.

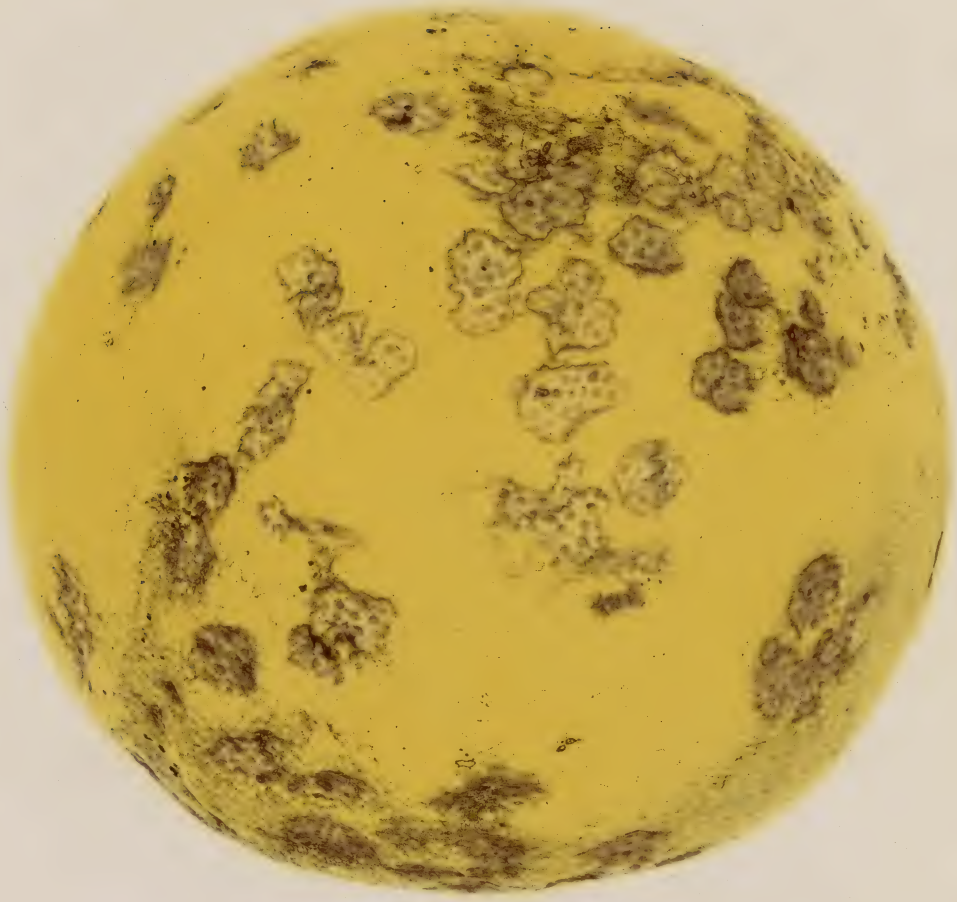
GRAPEFRUIT AND ORANGES: NAILHEAD RUST.

Cause: A fungus (Cladosporium herbarum).

The spots characteristic of this disease are quite similar to those commonly known as "Pox" or age spot. The two differ however, in this respect; nail head spots often begin as sunken rings with a higher healthy part inside. This afterwards sinks also and the whole spot becomes diseased. True "Pox" spots never show these rings.

Nail head rust is sometimes severe in the field but is not common on the market.

Control methods include top working to resistant varieties, pruning out dead wood, heading back and spraying.



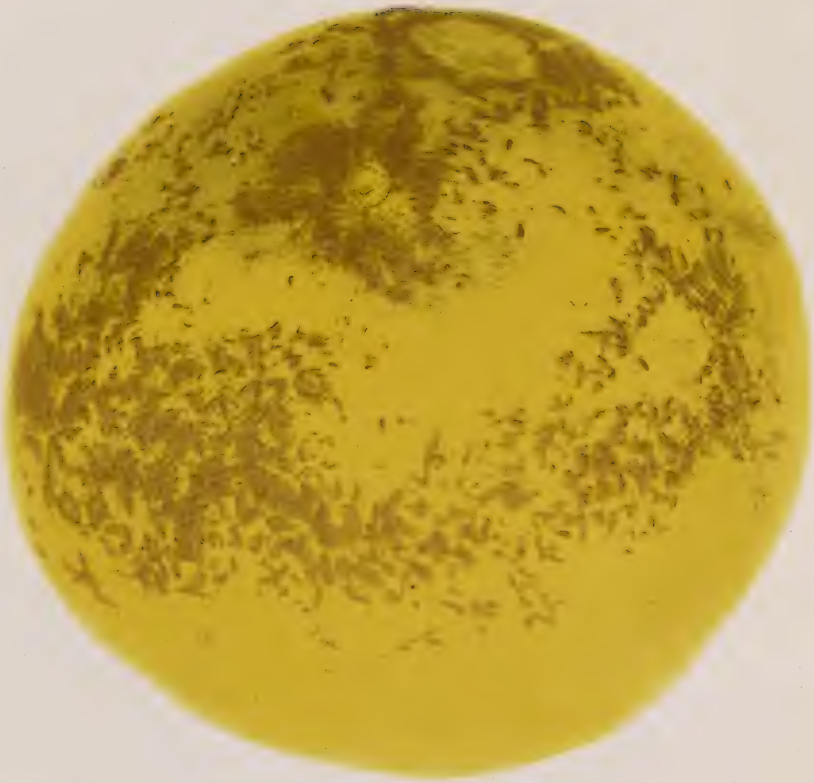
GRAPEFRUIT POX

GRAPEFRUIT: POX.

Cause: Unknown.

The chief characteristic of this disease is the development of sunken, irregular spots in the skin, usually on the blossom half of the fruit. These spots are not discolored at first but later they assume a somewhat pinkish to brown color. They vary in diameter from one-fourth of an inch where they occur singly to one and a half to two inches where several of them coalesce. Softening often occurs underneath the spots but they are rarely accompanied by decay unless the blue mold fungus gains an entrance. Occasionally the flesh beneath large pox spots has a tainted taste. In the affected areas of the rind the oil sacks stand out very prominently since they are of a slightly darker color than the affected tissue immediately surrounding them.

The disease may occur on the fruit at time of packing but usually does not develop until after a storage period of a week or ten days. It sometimes develops in transit. In any case affected fruit always brings a lower price than unaffected fruit of otherwise similar quality. The only suggestion that can be made as to control is that storage of the fruit for longer than a week or two should be avoided whenever possible.



GRAPEFRUIT PURPLE SCALE.

GRAPEFRUIT: PURPLE SCALE.

Cause: An insect (Lepidosaphes beckii).

The purple scale is essentially a citrus fruit pest, although its attack is not restricted to plants of this family. The adult female will average 1/20 of an inch in length. The scale covering in general color is a brownish purple and its shape resembles that of an oyster shell. A fungus parasitic on the scales is often found associated with them or scattered among them, in the form of a small red or pinkish dots or pustules.

Injury to the fruit is due directly to the feeding of the insect and if present on ripe fruit, has a tendency to delay coloring. Owing to their firm attachment of the fruit scales are removed with great difficulty and for that reason are often found on fruit after it reaches market.

GRAPE FRUIT SCAB.

GRAPEFRUIT: SCAB.

Cause: A fungus, (Cladosporium citri).

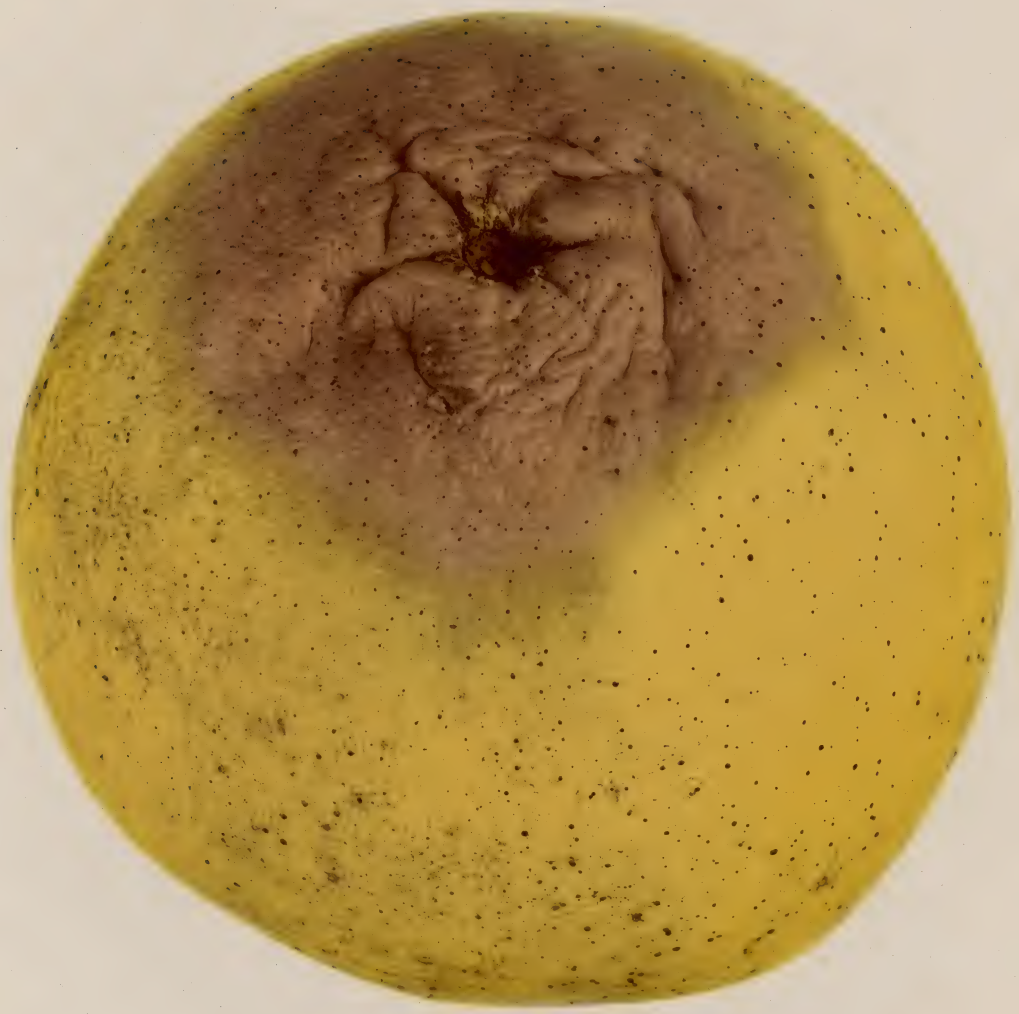
Citrus scab is a disease of grapefruit, sour orange, rough lemon and sometimes is found affecting limes, tangerines and sweet oranges. It is found on Florida, Porto Rico and Cuban products but has not been reported from California. On the market it makes its appearance on grapefruit and to some extent on limes.

The fungus attacks the young leaves, twigs, and fruit. After the fruit becomes an inch or so in diameter the organism is unable to attack it. The leaves are affected only while they are young.

The first signs on the diseased fruit are small raised areas which are whitish at first but which later assume a pinkish or brown color. The protuberances may be single or they may coalesce to form large patches of brown scab.

The disease affects only the rind of the fruit, making it unsightly and causing it to sell as inferior stock. It does not spread during transit. Since infection takes place when the fruit is small there is no danger of new infections taking place on mature fruit.

Scab is strictly a field disease, which can be controlled by proper spraying with Bordeaux mixture.



GRAPEFRUIT STEM-END ROT.

GRAPEFRUIT: STEM-END ROT.

Cause: Phomopsis citri and Diplodia natalensis.

Symptoms: Softening of peel and underlying pulp, beginning almost invariably at the stem, and extending rapidly until the whole fruit is involved. In the early stages there is little or no discoloration, but about the second day light brown discoloration is apparent. This never becomes very dark in Phomopsis stem-end rot. In Diplodia stem-end rot a very dark brown to black color is developed after three or four days. The rot progresses rapidly down the central axis, and usually reaches the point end by this route sooner than through the surface peel. There is sometimes a tendency to extend in the peel most rapidly along the lines marking the divisions between the fruit segments. At ordinary temperatures the rot may extend an inch a day, requiring four or five days to completely rot the fruit. The fruit does not shrivel or lose its shape unless subjected to pressure. The taste is flat and somewhat bitter. Ordinarily no fungus growth is produced over the surface.

In early stages the Diplodia and Phomopsis types of stem-end rot are not very much differentiated. The darker color of the Diplodia rot will distinguish it after a few days. This color is apt to develop early in the central axis. If fruit is held in moist chambers, a surface growth of mycelium may be secured which is white for Phomopsis and smoky to olive-black for Diplodia. Both rots may occur in the same lot of fruit. Phomopsis is the more frequent in Florida fruit, and Diplodia in fruit from Porto Rico and Cuba.

Penicillium may invade stem-end rot lesions and confuse the appearance and diagnosis.

If there is question about the identity of any case of rot, select specimens representative of various stages, wrap separately in clean paper, moisture-proof if possible and hold for a few days in a closed vessel in a warm place. Such treatment often brings out distinctive features over night. There should be no difficulty in differentiating between stem-end rot (either type) and blue mold rot. In the latter the skin is much softened and

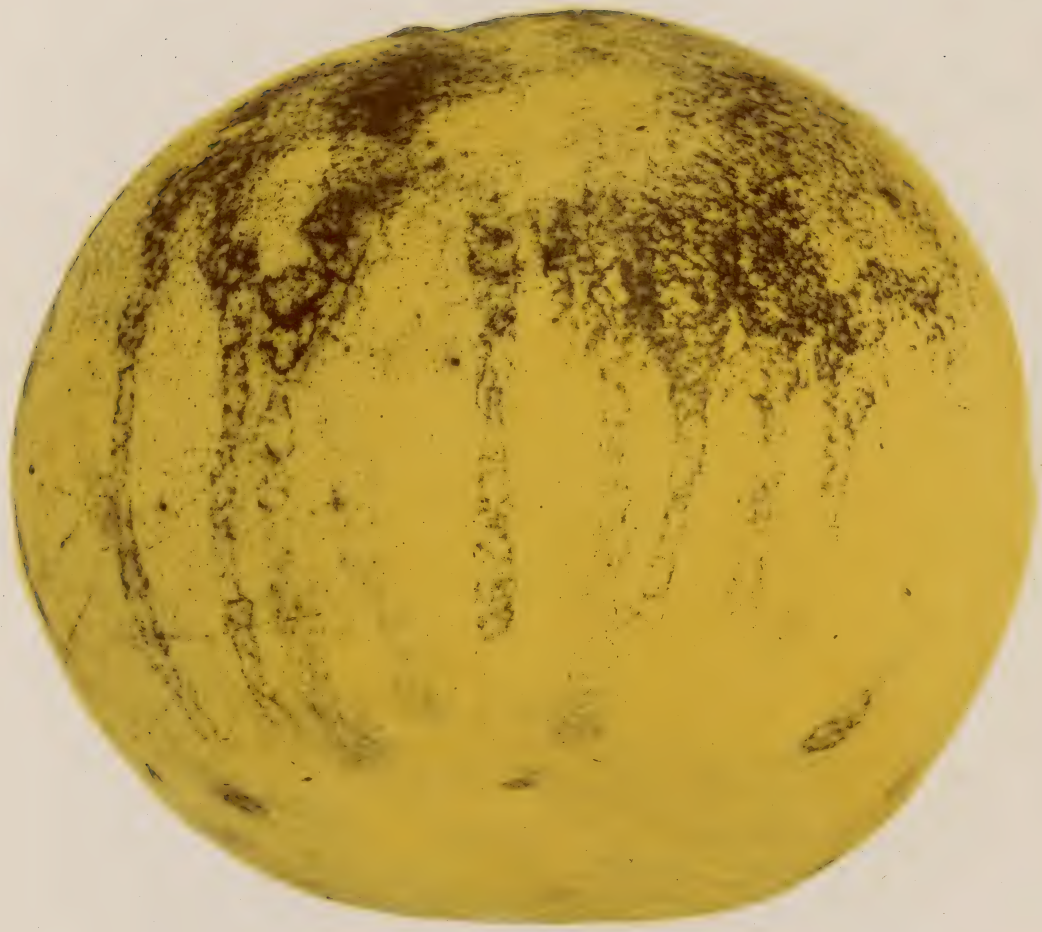
so tender that it breaks easily under pressure from the finger; the peel has a water-soaked appearance and loses some of the natural yellow color but is not browned; spore production takes place very early. In stem-end rot the peel is brown, and not easily broken; spore production rarely occurs.

Both Phomopsis and Diplodia occur on dead twigs in citrus groves, sporulating in abundance under favorable conditions. Neither fungus forms spores readily on the decayed fruits. Except for possibility of growth of mycelium from a decayed fruit to adjacent ones in the box, which probably occurs only under high moisture conditions and then somewhat slowly, it would seem that infection must precede the packing of the fruit. The chances for spore contamination would seem to be greater in the groves than in the packing houses. Certain conditions are necessary for this to take place on a large scale, and these conditions do not occur every season, but as a rule at intervals of several years. No grove practices have been developed that give thoroughly satisfactory control. Pruning out of dead limbs and twigs to diminish the sources of infection is a helpful measure. This also tends to decrease the melanose spotting of immature fruits, which is caused by Phomopsis citri.

While stem-end rot may under some conditions attack fruits in the grove, causing them to drop, it sometimes happens that the rot does not develop to any important degree in the grove, because of low temperature or other inhibiting factors, and yet becomes very severe in the marketed fruit. It is impossible to distinguish and cull out sound fruits that may later develop stem-end rot. At ordinary temperatures the crest of stem-end rot in fruit packed as being to every appearance perfectly sound is reached in 10 to 20 days after packing. This period can be greatly prolonged by cooling the fruit. For best results this cooling should follow picking or as soon as practicable thereafter; but even in the care of lots that have begun to show rot, holding in an ice box or under

other refrigeration will greatly prolong the period of marketability.

In so far as present knowledge goes, practical prevention of excessive market loss from stem-end rot, in seasons when it prevails, depends on prompt marketing and consumption of the fruit with as continuous cooling during handling as may be practicable.



GRAPEFRUIT TEAR STAIN.

TEAR STAINING OF CITRUS FRUITS.

Cause: Fungus (Colletotrichum gloeosporioides).

This blemish of citrus fruits is found on oranges and grapefruit coming from Florida, California and Porto Rico.

At the stem-end of the fruit there is usually a large russeted area; extending from this area toward the blossom-end are tear-stain-like brown streaks which gives this blemish its name.

The fungus which causes this disease lives in the dead wood on the tree. During a rain the spores are washed down onto the top of the fruit. As the water trickles down over the fruit it carries some spores along. These germinate and corrode the surface forming the streaks. This form of russet is also greatly aggravated by the presence of small insects known as mites. In fact some persons believe that the mites are the real cause of the trouble and that the presence of the fungus is only accidental.

In California this blemish can be found after the winter rains begin. During the dry summer and fall the blemish does not make its appearance.

LEMON BROWN ROT

LEMON: BROWN ROT.

Cause: A fungus (Pyhtiacystis citrophthora).

This disease is characterized by a light to dark chocolate-brown color of affected tissues and a pronounced but not offensive odor, sometimes described as rancid. Except when the fruit is held in a close, confined space there is no external fungus growth. Diseased fruits remain firm and retain their normal shape, a characteristic which, taken in connection with the others just mentioned, is of considerable value in distinguishing this from other lemon rots.

Brown rot is of economic importance only in California, although it has been reported as occurring in Florida and Cuba. It occurs only rarely on the market.

Since the fungus develops in the soil, there is considerable infection of fruits hanging low on the trees by the splashing of water from the soil surface during rains. The disease is prevented in the orchard by covering the ground with straw during the rainy season or by spraying the ground and lower branches with Bordeaux mixture. In the packing house good control is obtained by using copper sulphate at the rate of one pound to eight hundred gallons of water in the washing tanks.

LEMON COTTONY ROT.

LEMON: COTTONY ROT.

Cause: A fungus (Sclerotinia libertiana).

As the name indicates, this disease is characterized by a white fluffy or cottony growth of fungus on affected lemons. The skin shows a brown color, which is not, however, as dark as that seen in Alternaria rot. In fact, infected tissue may show at first only a pale lemon color with perhaps a tinge of brown. The fruit keeps its normal shape until the disease is fairly well advanced, since in this rot as in other lemon rots except that caused by Alternaria the early attack of the fungus is confined to the skin. In later stages all of the tissues are affected and the fruit becomes broken down and watery. By the time this condition is reached, large black sclerotia (resting-bodies) are usually to be found, similar to those occuring on celery, lettuce and other vegetables attacked by this fungus.

Cottony rot is distinguished from gray mold rot by the lighter brown color as noted above and also by the white, cottony, non-spore producing mycelium. Gray mold produces large numbers of spores, in small tufts or bunches that are easily seen by the unaided eye; in mass, the color of the spores and mycelium is a mouse gray.

The disease attacks not only the fruit, but also the twigs of trees of any age. It also occurs on nursery stock. Its occurrence and spread in a grove is favored by the presence of cover crops but this fact is not considered an argument for leaving such crops out of the scheme of grove management.

The rot is of economic importance only in California but is known to occur in Florida and Cuba.

It is less common than formerly, probably because of the general use of control methods recommended by the California station. These are: (1) disinfecting the fruits by the use of a wash water containing one-fiftieth of one per cent copper sulphate, (2) the sterilization of field and storage boxes, (3) frequent inspection, especially of stored fruit from infected groves, (4) the isolation of fruit that may have been infected by contact.

LEMON FUMIGATION INJURY

LEMON: Fumigation Injury.

Cause: Hydrocyanic acid gas.

When citrus trees are fumigated for insect pests, if the work is carelessly done or the dosage too heavy, a pitting or scarring of the fruit often results. It happens in rare cases also, that a dosage which has no effect on the fruit under ordinary conditions of the weather, may a few hours later, with these conditions changed, produce a wholesale spotting.

The scars are irregular in shape, shallow, and of importance only as blemishes. They differ from the so-called "pox" or "anthracnose" spots in being only very slightly sunken and not symmetrical in outline.

The injury is more likely to occur on fruit from California than on that from Florida, since fumigation is more generally practiced in the former reigon than in the latter.

LEMON GREEN MOLD ROT.

LEMON: GREEN MOLD ROT.

(See Orange: Blue mold rot).

LEMON ALTERNARIA ROT.

LEMON: ALTERNARIA ROT OR CENTER ROT.

Cause: A fungus (Alternaria sp.).

The disease makes its appearance on California lemons which have been stored for several months before shipping. It became so abundant during the season of 1919 that 10 to 25 per cent of the lemons arriving on the Philadelphia market were thus affected. Losses occurred on other markets but were not so heavy.

The rot usually enters the lemon at the stem-end and works through to the center rag, (the membrane forming the partitions in the fruit) or spreads under the skin. In the early stages it is almost impossible to detect the condition by casual examination but it has been noted that lemons in an early stage of the disease are frequently very puffy.

The rot develops rapidly, breaking down the rag until it becomes a slightly slimy, leaden-brown mass and then continues to work outward through the rind. When it reaches the surface one or two spots about half the size of a dime become apparent. These increase in size rapidly and become a deeper leaden brown as they enlarge until the entire rind is broken down into a slightly slimy, leaden-brown mass similar to the decayed rag. The flesh of the lemon is last to break down. No disagreeable odor is present. There is often associated with this rot a fungus (Aspergillus) which gives a reddish cast to the decayed rind.

Center rot develops rapidly in fruit already affected, and spreads readily from decaying to sound stock.

Next to blue mold, this is the most serious market disease found in lemons. Brown rot is probably more destructive in the field but rarely occurs on the market.

LEMON PIT OR PETECA

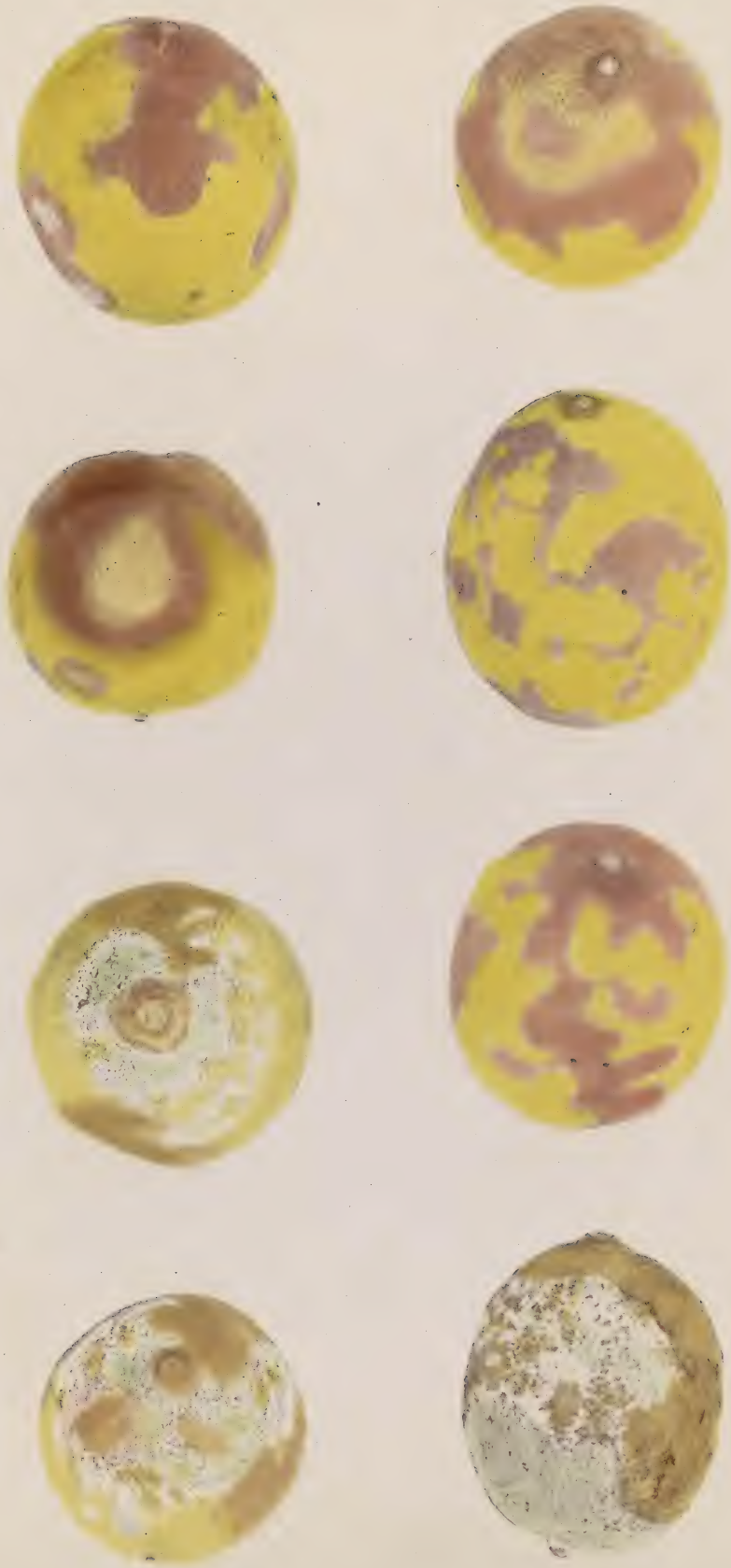
LEMON: PIT OR PETECA.

Cause: Unknown.

Lemons affected with this disease show slightly sunken spots which vary in diameter from one-eighth to one-quarter of an inch and in color from greenish to light brown. On cutting they are seen to effect only the peel. They occur during the fall and winter and then, usually, not until the fruit has been in the curing house for some time.

Little is known of the disease except that it is non-parasitic. It causes considerable loss in the groves at times, but is not common on the market.

Nothing is known as to methods of control.



LIME SCALD AND BLUE MOLD ROT.

LIME: SCALD AND BLUE MOLD ROT.

Cause: Unknown.

Limes often become spotted after they arrive on the market, usually within the first ten days. The spots are purple to brown in color and very irregular in shape and size. Sometimes the whole lime becomes purple, then turns brown. The disease seems to be a physiological breakdown, but, under laboratory conditions, even though the lime has been sterilized, there appears a fungus known as Diplodia. Up to the present time, however, there is no proof that this fungus causes the injury.

In the winter time lime scald is sometimes ascribed to freezing injury but the fact that it occurs just as often when there is no possibility of freezing is sufficient argument against this theory.

Under market conditions, soon after the lime has turned brown, blue mold may make its appearance and the fruit be reduced to a soft watery pulp.

Limes affected with this disease bring a lower price than sound fruit but in many cases the quality of the flesh seems to be unaffected. Occasionally a tainted, moldy taste can be detected, immediately underneath the spots.

(See also Orange: Blue Mold Rot).

ORANGE BLACK ROT OR ALTERNARIA ROT.

ORANGE: BLACK ROT OR ALTERNARIA ROT.

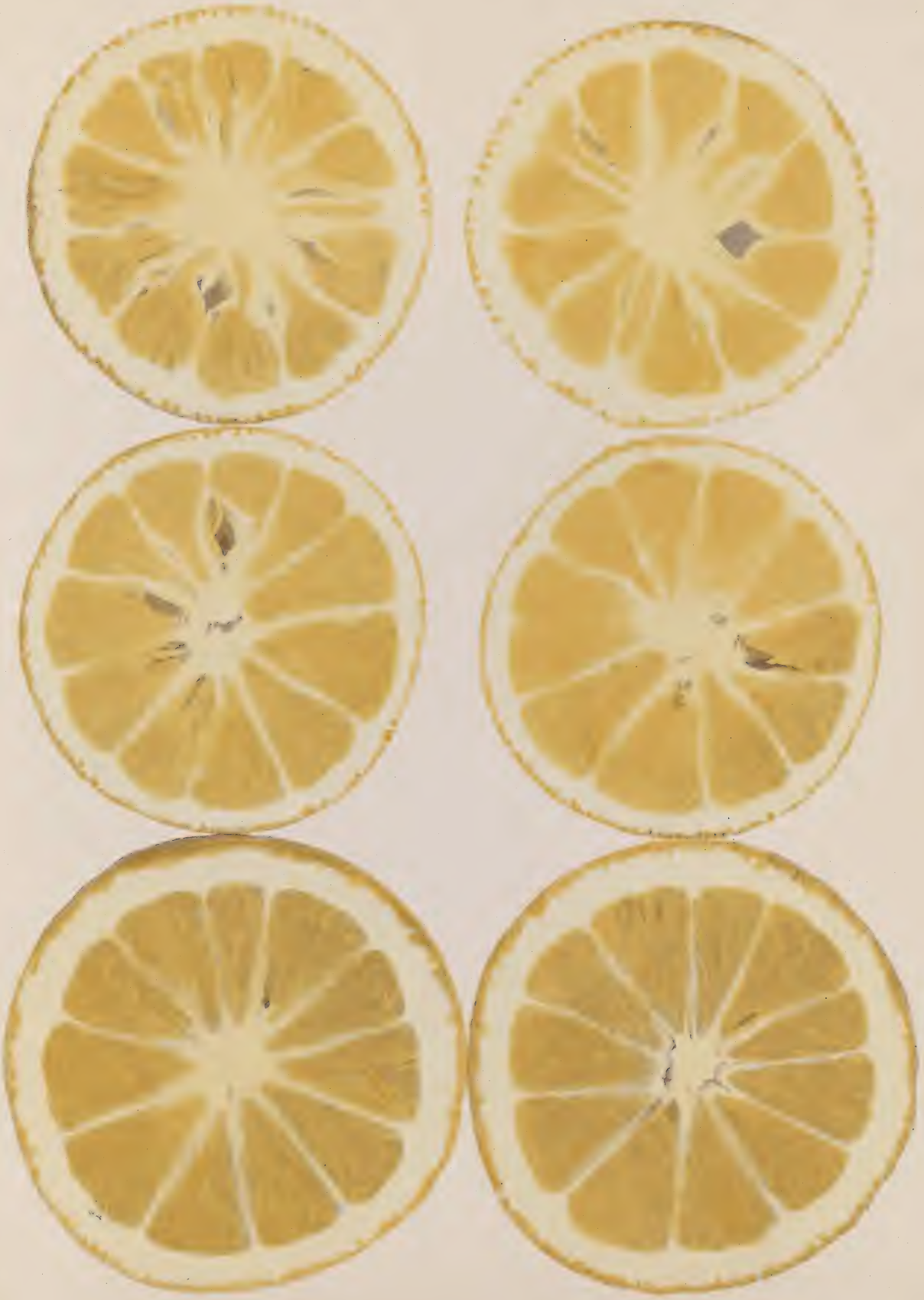
Cause: A fungus (Alternaria citri).

This disease, a brownish or black decay at the blossom end of the fruit, is most common on California navels but is sometimes found on Florida stock. In California infection takes place through the navel when the fruit is young. Affected fruits, which usually color up ahead of the main crop, may show the rot only on cutting or they may, in storage or in transit, develop a rot that involves the whole blossom end and is readily apparent from the outside. When only the interior of the navel is attacked the affected tissues are black; when it reaches the outside, the skin shows merely a dark brown color.

In Florida oranges the rot is not masked or covered by a navel and is therefore plainly evident, almost from the beginning. But even here, decay often spreads along the inside of the peel and down the central axis, when the affected area apparent from the outside is only a half inch in diameter or less. Typical specimens show a dried-out crack a quarter to a half-inch long, in the diseased peel.

Black rot sometimes causes appreciable loss in the field but it is not common on the market.

No special studies have been made of methods of control.



ORANGE FREEZING INJURY

ORANGE: Freezing Injury.

Cause: Low temperature.

Tree-frozen oranges develop sooner or later a number of symptoms which distinguish them from normal fruit. The most marked of these is a drying out of the pulp and, usually, a more or less open condition caused by a separation and collapse of the segments when they dry. The stages of this condition most commonly recognized are "slightly open", "open", and "dry". Other symptoms which may or may not occur are patches resembling sunburn, slightly sunken blotches, thickened skin, dewey appearance of the rag, and small white bodies on the rag which have the technical name of hesperidin crystals.

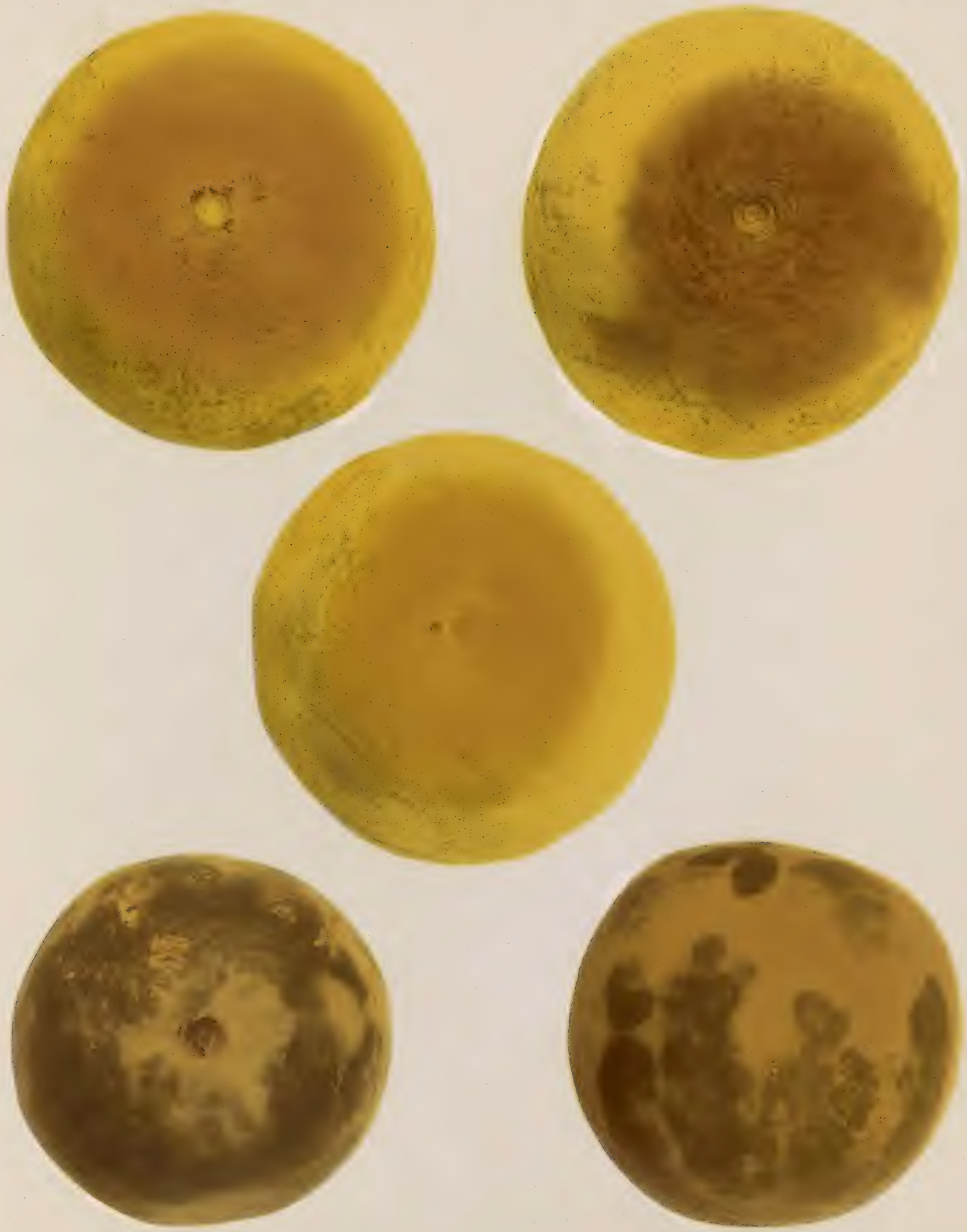
If the temperature conditions are favorable, the fruit may arrive without showing dryness and in California fruit can be detected only by spreading the sections and looking for hesperidin crystals. Florida fruit may show a mushy condition.

Injury from freezing on the tree will be found in boxes without relation to their location in the car but may be confined to certain brands in the shipment.

Freezing in transit will seldom show in the form of "drying out" as in field frozen stock. When the fruit does not show ice on cutting, other symptoms will have to be depended on in making a diagnosis. Oranges will often be bitter in flavor for a time, but this is not a constant factor. If the freezing has been severe a mushy condition will be found in the cross section. This condition is best seen if both ends of the orange are cut off and a cut then made through the rind of the central portion so that the sections can be puled apart. When this is done, the membrane between the sections, (the rag), will show a soaked condition and usually a number of the hesperidin crystals mentioned above. The damage may be confined to a part of the orange, in which case the signs suggested will be found on one side of the fruit. This method of diagnosis is particularly useful for California oranges. Florida fruit, less easily examined in this way, usually shows the mushy condition in cross section.

Lemons and grapefruit show the damage in cross-section much more frequently than oranges, although it is desirable at times to pull grapefruit sections apart as described above for oranges. If lemons have been seriously damaged the pulp becomes mushy at once after thawing.

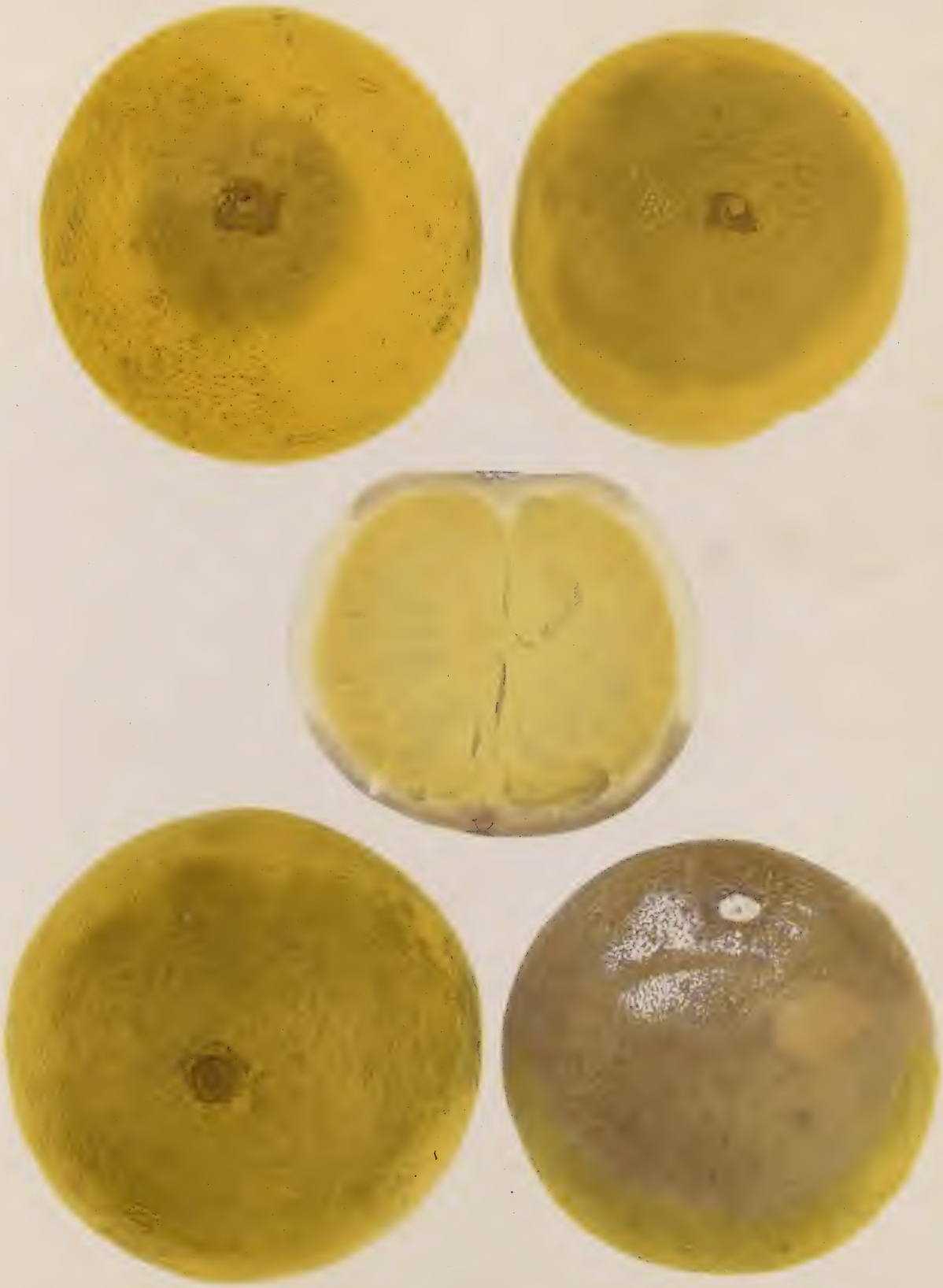
Freezing in transit will not usually be found throughout the car, but chiefly along the sides or the floor, or at the doorway.



ORANGE STEM-END ROT (DIPLODIA)

ORANGE: STEM-END ROT (DIPLODIA).

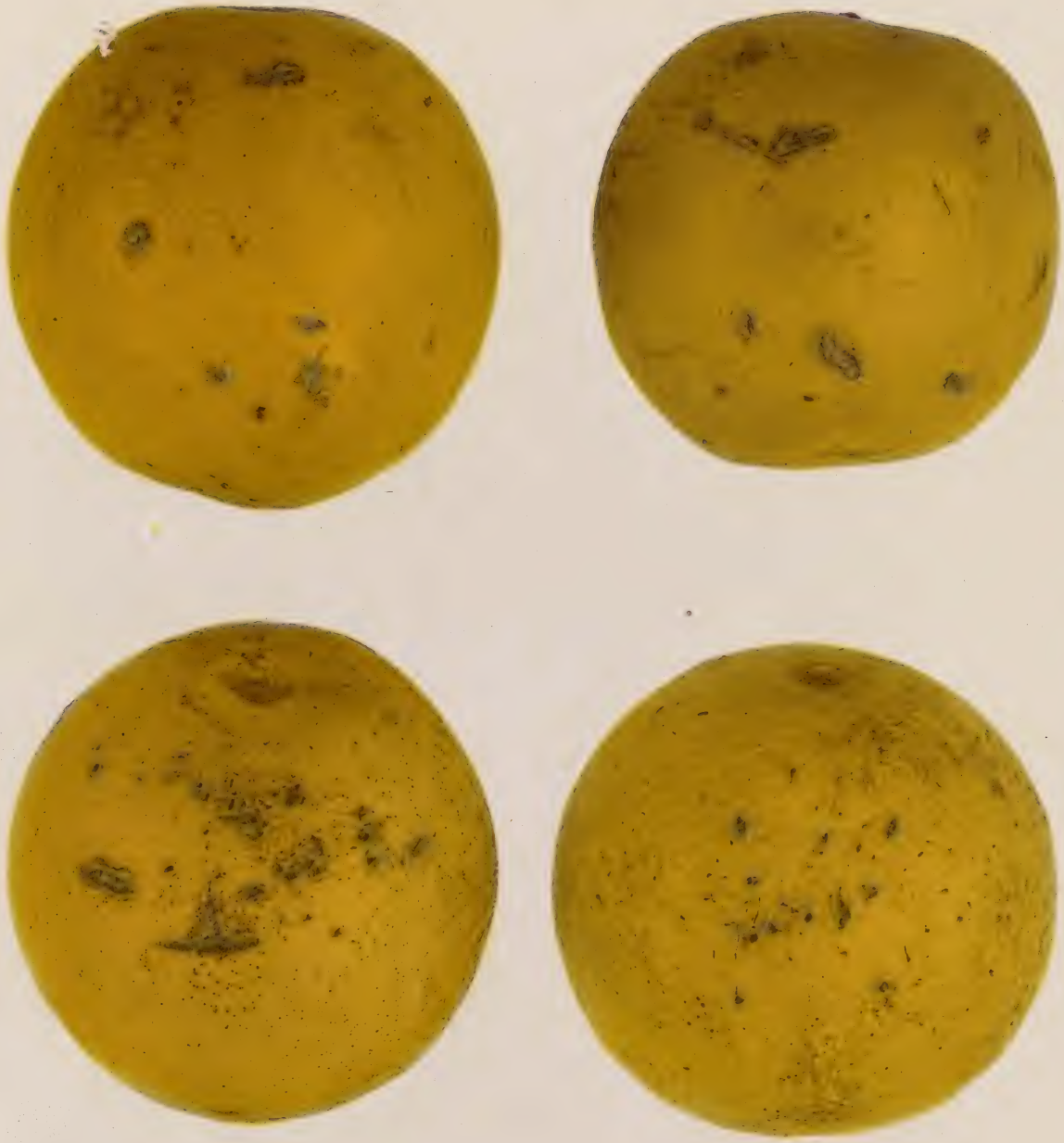
(See Grapefruit: Stem-end rot).



ORANGE STEM-END ROT

ORANGE: STEM-END ROT.

(See Grapefruit: Stem-end rot).



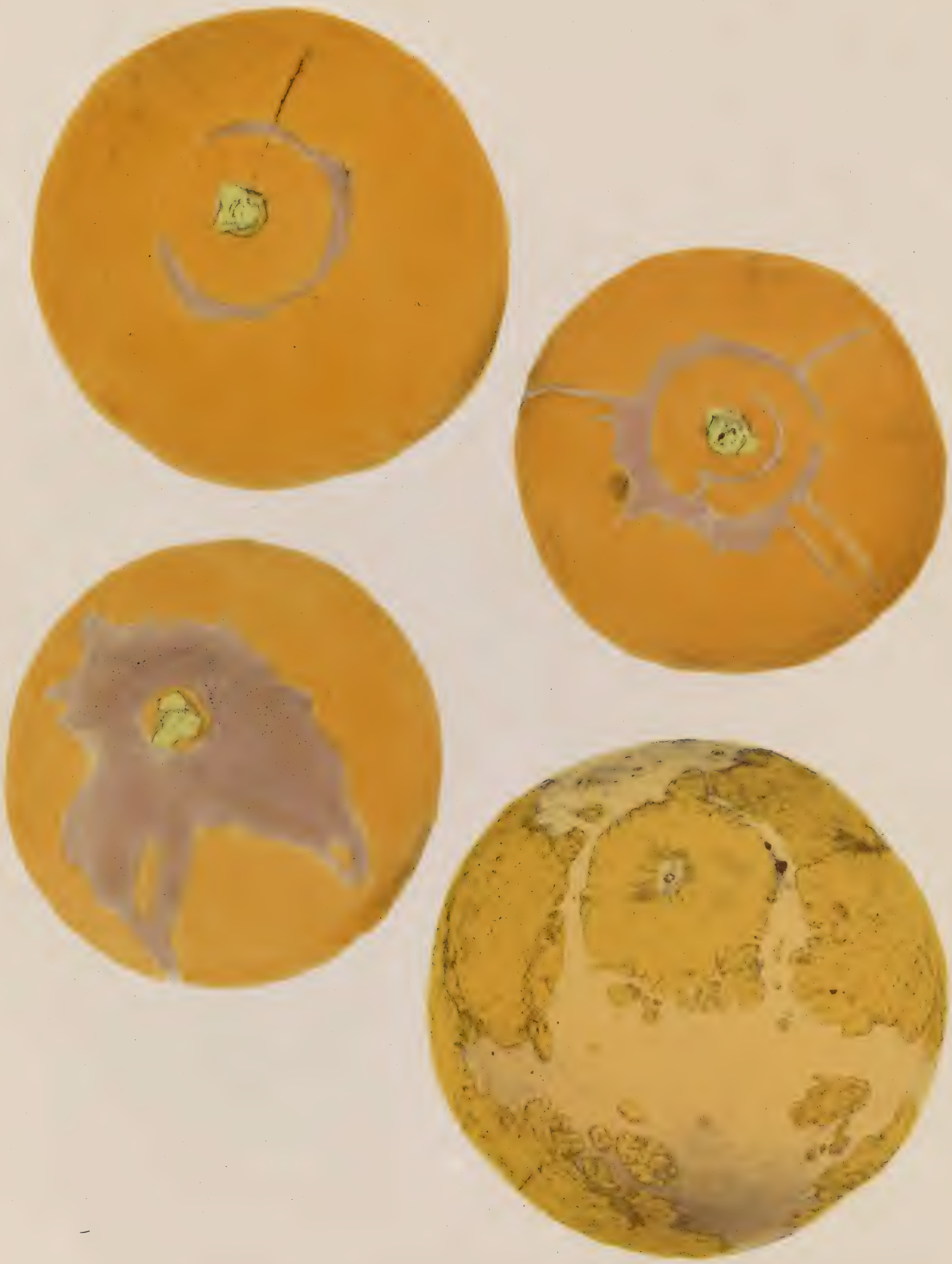
ORANGE THORN INJURY

ORANGE: THORN INJURY.

Cause: Punctures by thorns.

Injuries of this sort are often found on both California and Florida fruit. When they are deep and well marked they can hardly be mistaken for anything else. When shallow they sometimes resemble bruises.

Infection with blue mold may, but does not often, follow the injury.



ORANGE THRIP INJURY

ORANGE: THRIPS INJURY.

Cause: An insect (Euthrips citri).

Injury by this insect consists of roughening or scabbing of the skin which on California oranges occurs in the form of a band or ring at the stem end. In Florida it sometimes occurs also as the irregularly shaped smooth shiny blotches known as silvery scurf.

The adult citrus thrips is among the smallest of insect pests, averaging from 1/40 to 1/28 of an inch in length. The sweet oranges suffer the greatest damage from this pest, especially the varieties known as Washington, Thompson's improved, Australian navels, Parsons Brown and Homosassa. Valencias are damaged considerably when the trees are young.

Injury to citrus trees and fruit is caused by the feeding of both adults and larvae upon the surface of the parts attacked. Feeding may be on both young and nearly mature fruit and on new, tender foliage. The characteristic scabbing of the fruit is started when the fruit is very small. This scabbed area is small at first but increases as the fruit grows, owing to the continued feeding of the thrips. If the fruit is heavily infested the entire surface may be scabbed and in some instances the fruit is misshapen or may fall before it matures.

CRANBERRY FUNGOUS ROTS.

SOUND

INJURED.
CRANBERRY SMOTHERING INJURY.

CRANBERRY DISEASES: FUNGOUS ROTS

END ROT.

Cause: A fungus (Fusicocugi putrefaciens).

This rot is characterized in early stages by a softening at either the stem end or the blossom end of affected berries, rarely on the side, which finally passes over into a softening and destruction of the entire berry. There is usually little or no discoloration. The disease can be confused with severe freezing since both reduce the berries to a "water bag" condition, but there should be no difficulty in distinguishing it from slight freezing since it does not destroy the inside structure. To detect the disease in barrels run the hand deep down into the berries; if "water bag" or end rot berries are present they will be heard to explode.

End rot occurs on all varieties and in all producing districts. Berries from the Pacific coast are frequently a total loss because of this rot.

EARLY ROT.

Cause: A fungus (Guignardia Vaccinii).

This disease occurs chiefly in the bog, while end rot is restricted to berries in storage. Early rot is characterized by small discolored areas, usually brownish, which begin on the side and finally involve the entire berry. These areas frequently show dark rings or even a target-board marking.

The disease can be distinguished from end rot by The rather tough rubbery character and the brownish discoloration of affected tissues. It does not produce the "water bag" condition characteristic of end rot.

Early rot attacks berries from all localities and no variety is wholly immune. It is likely to occur on the market very early in the season.

BLACK ROT.

Cause: A fungus (presumably Ceuthospora lunata).

The berries are shiny black; rubbery or tough and pliable rather than mushy.

These three diseases are practically the only ones that can be diagnosed with any degree of accuracy by the outward appearance of the berries. There are many other important diseases but considerable experience is required to enable one to identify them by superficial symptoms. For this reason inspectors should describe miscellaneous lots of diseased berries that do not fall within three types already mentioned simply as showing "rot". If there is question in the mind of the inspector as to the correctness of his diagnosis the same term should be used.

"FROST NIP" OR FREEZING INJURY.

The berries are tough and rubbery, lacking in the characteristic bounce and high luster and usually slightly sticky. The color leaves the epidermis and permeates to all parts of the interior structure. The interior structure is not des troyed - the four carpels of the berry remain intact, but berries have a typical wilted appearance. Very severe freezing in the bog will reduce berries to a water bag or mushy condition but such berries are not apt to reach the market.

SMOTHERING.

All symptoms of freezing injury are duplicated in "smothering", which is due to the presence of excessive amounts of carbon dioxide gas, a by-product of the berries themselves. An accumulation of carbon dioxide gas or covering berries with water will "smother" them, giving the wilted appearance and tough, rubbery feel but never reducing them to a water bag condition as in case of end rot. The location of the trouble in the barrel will assist the inspector to determine the cause. If the outside berries are effected, but the inside or core of the barrel sound and bright, freezing injury might be suspected; if the core of the barrel is wilted and the outside berries sound and bright smothering might be suspected.

GOOSBERRY MILDEW.

GOOSBERRY: MILDEW.

Cause: A fungus (Sphaerotheca mors-uvae).

On the market, goosberries affected with this disease show irregular russeted patches which may involve only a part of the surface or, occasionally all of it. Badly diseased berries sometimes crack and decay. The mildew also attacks the leaves and young fruits, producing distortion in many cases, and lowering the vitality of affected plants. In the field its presence can be detected by the moldy,powdery appearance of diseased parts.

The disease occasionally causes heavy loss in the field but is not often seen on the market. It was imported into Europe from the United States in 1890 and has become much more virulent there than here.

Fairly good control can be obtained by spraying with potassium sulphide (liver of sulphur.)

GRAPE GRAY MOLD ROT.

GRAPE: GRAY MOLD ROT.

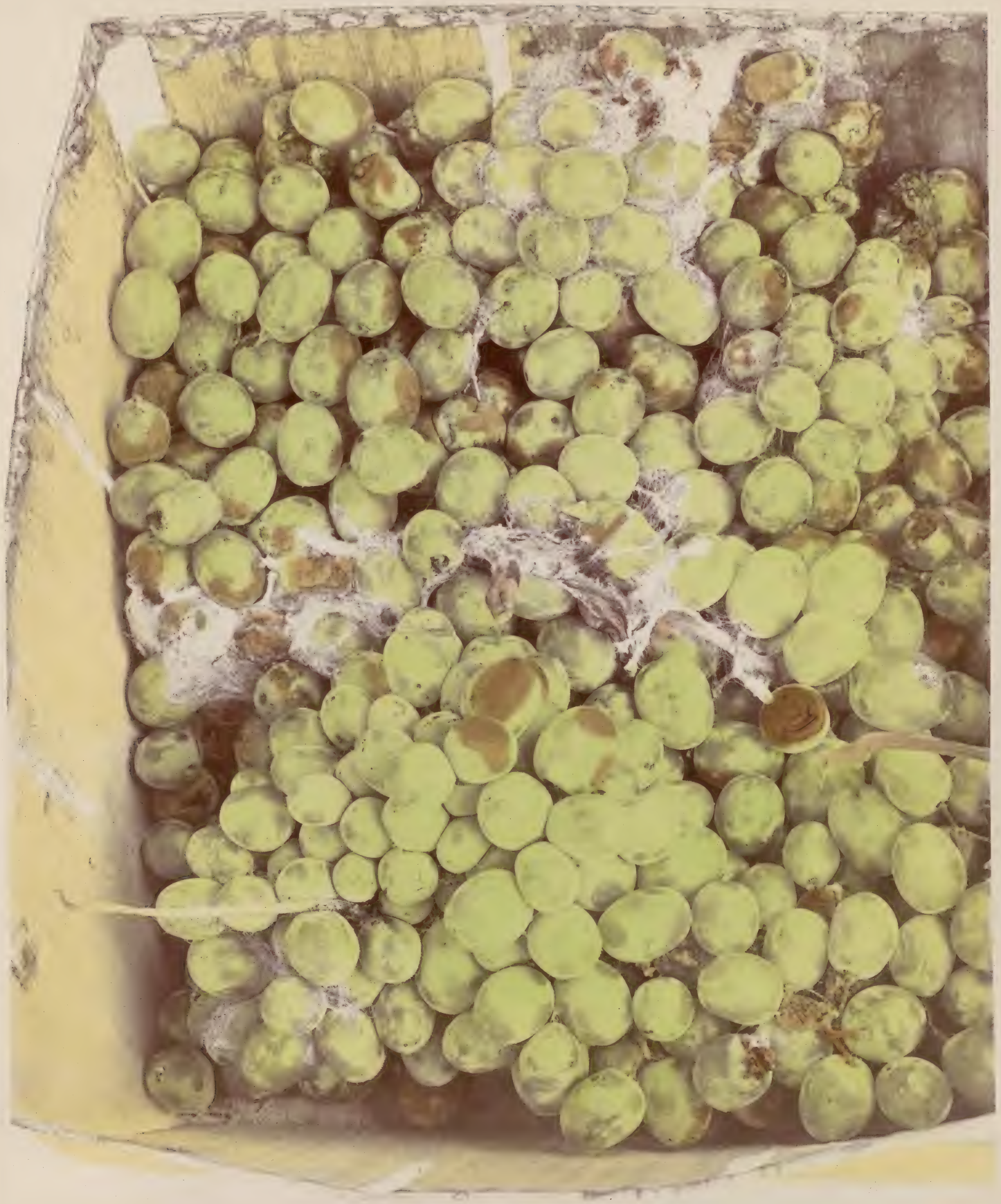
Cause: A fungus (Botrytis cinerea).

This fungus attacks a great variety of fruits, among them strawberries, blackberries,raspberries, grapes, citrus fruits and apples. In some fruits as also in some vegetables it causes a watery soft rot. In lemons it causes a brown rot which resembles very much the true brown rot of this fruit, but which has a darker chocolate brown color than brown rot. In strawberries the affected berry is hard and dry, since the juice evaporates more slowly than in leak (due to Rhizopus). In late stages the fungus produces a gray growth which covers the entire berry. In grapes the fungus produces a semi-watery rot and in many cases a gray growth which covers the affected berries.

The fungus is at first entirely within the fruit attacked; later on it grows on the outside forming a white cottony mass which, when the spores are produced, becomes gray. The spores are easily distributed and when they fall in a suitable environment they germinate, the fungus enters the fruit and decay begins. Gray mold grows less luxuriantly than Rhizopus, the fungus threads are rather fine, not coarse and stringy, and the spores are borne exposed on special branches not in black spore cases (sporangia) like those of Rhizopus. Gray mold, when producing spores in quantity has a gray velvety appearance never shown by Rhizopus.

Gray mold has a wide distribution and therefore is found on practically all kinds of fruits and vegetables. It spreads rapidly in transit if the cars are not properly iced and to some extent even if they are, differing in this respect from Rhizopus, which will scarcely grow at all at low temperatures. The bad cases seen on the market can usually be traced to faulty conditions sometime during transportation. However, if there is cold rainy weather at picking time, especially in the case of strawberries, this fungus may cause serious losses on the market, even though the cars moved on time and were properly iced.

Control of the rot is not easy but something can be done toward it by avoiding picking during cold wet weather and by keeping cars well iced during transit.



GRAPE RHIZOPUS SOFT ROT.

GRAPE: RHIZOPUS ROT.

(See Strawberry: Rhizopus rot).

PEACH BACTERIAL SPOT OR SHOT-HOLE

PEACH: BACTERIAL SPOT.

Cause: Abacterium (Bacterium pruni).

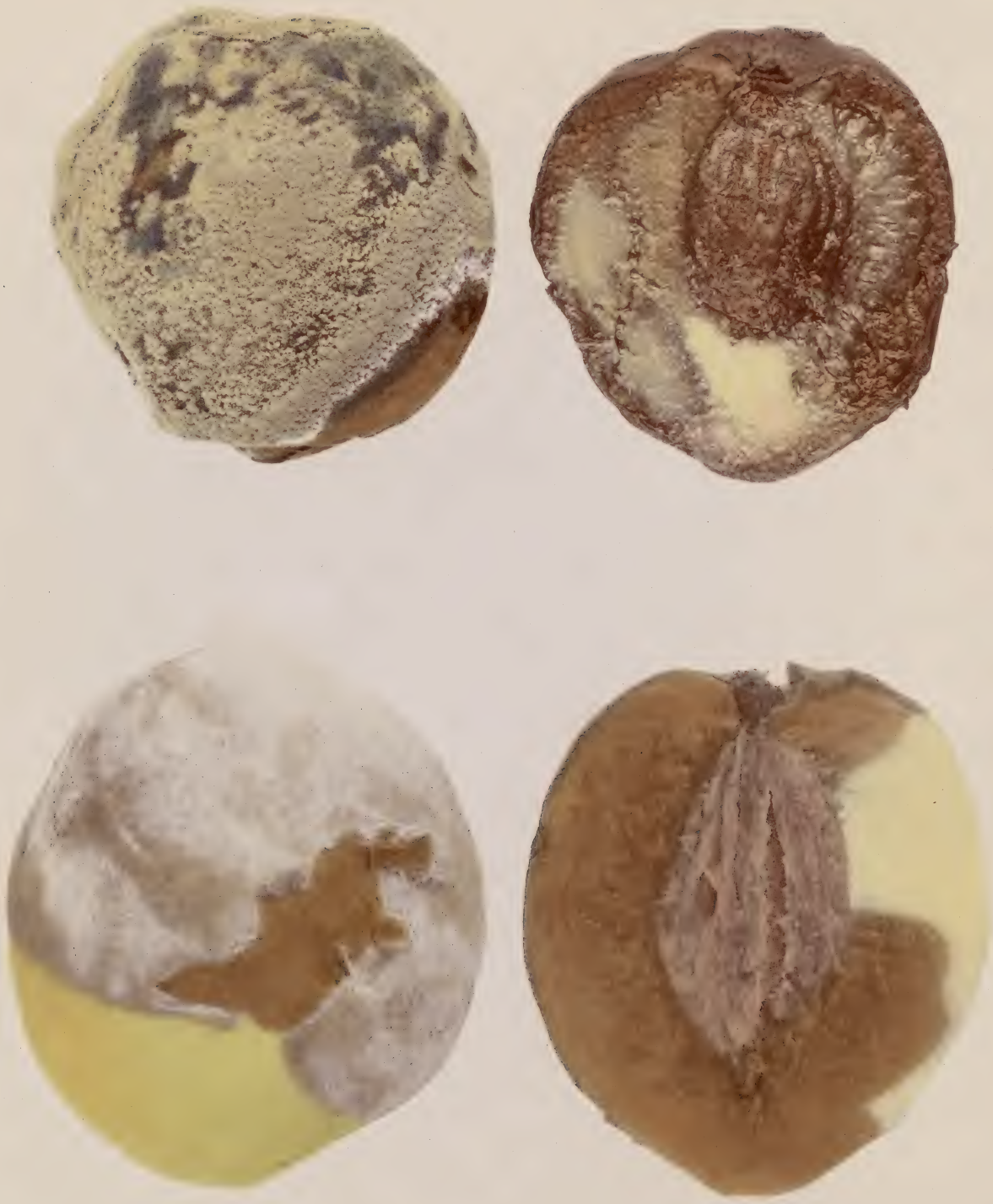
The signs of this disease are small irregular brown spots somewhat resembling cracks, scattered over the surface of the peach or grouped in small patches. Occasionally the spots coalesce to form areas an eighth to a quarter of an inch across and a sixteenth of an inch deep.

The spots are caused by bacteria which also cause a disease of the leaves and twigs. The latter are the source from which infection spreads in the spring to the leaves and fruit.

The disease causes no rotting but is important merely as a blemish. It occurs to some extent every year in the southern peach growing section and is sometimes seen in northern sections. Serious outbreaks result in considerable loss from blemished fruit but these are not very common.

Fairly good control has been obtained by the use of fertilizers and thorough cultivation, both being practices which increase the vigor of the tree.

PEACH — BROWN ROT.



PEACH BROWN ROT. RHIZOPUS ROT (BELOW.)

PEACH: BROWN ROT.

Cause: A fungus (Sclerotinia cinerea).

The disease on the fruit makes its appearance as small brown circular spots which under favorable conditions soon involve the whole fruit. The spots are usually not sunken and the fruit remains plump until almost entirely decayed. The fungus growing on the tissues breaks through the epidermis forming small gray spore-bearing tufts, which may be scattered irregularly over the rotten spot or may become so numerous as to give the whole spot a grayish appearance.

The spores are produced in great abundance. They become powdery when the masses in which they are produced dry out, and on being disturbed arise in a dust which is easily distributed by the wind or by the insects. Chief among the latter is the plum curculio,the eggs of which, on hatching, produce the worms so often found in stone fruits. Where worm and rot occur in the same fruit, infection probably took place at the egg puncture, through spores borne either by the insect or by the wind. The brown rot spores also find entrance at curculio feeding punctures. In the Northwest, stone fruits grown west of the Cascades sometimes become infected with the rot at injuries made by the Syneta leaf beetle.

Brown rot and Rhizopus rot of peaches are easily distinguished if the fungous growth appears; brown rot by the gray spore-bearing tufts and Rhizopus rot by the coarse stringy mycelium and black sporangia or spore cases. If no fungous growth appears, the two rots are sometimes confused. They can be differentiated, however, as follows: brown rot lesions are rather firm and tough, have no marked odor and the diseased skin clings to the diseased flesh underneath; lesions due to Rhizopus are rather soft, with jelly-like masses of decayed tissue around the stone, often have an acid odor, and the skin slips readily under pressure from the finger. Both rots are rather watery but Rhizopus rot considerably more so than brown rot.

Bruised spots on peaches are usually a dull, dirty brown and to this extent resemble rot lesions. The color, however, is due to a breakdown

of the tissues following injury, not to the action of any parasite. A bruise is not a rot. The brown color is confined to the flesh whereas in rot lesions it is strongly marked in both skin and flesh. The brown area in bruised spots is not definitely limited; in rotten spots it is. And finally, bruises are usually sunken; rotten spots may or may not be but usually are not.

Brown rot affects all the stone fruits (peach, plum, cherry, apricot) and occurs in practically all regions where these fruits are grown. In the United States it is most prevalent and most destructive in the Southern peach growing regions but in warm, moist seasons often causes serious loss further north. In the northwest it occurs on cherries and Italian prunes but is not known to occur on peaches. The average annual loss to peach growers of this country is stated by Hesler and Whetzel to be about $5,000,000. The average annual loss in Georgia is estimated at 40 per cent of the crop.

Losses from brown rot often occur under conditions which make them hard to understand. It is no uncommon experience amoung growers to have peaches leave the orchard in apparently good condition and arrive on the market so affected with brown rot as to be practically worthless. Such a situation is probably to be explained in this way: when fruit is packed from orchards where brown rot is prevalent, some infected fruits, especially those only recently infected are bound to get through to the packers. Or fruit is packed on which brown rot spores have lodged but have not caused infection. In transit, if conditions are favorable - a moist atmosphere and a temperature between 45 and 50 degrees F. - the lesions already present enlarge and new ones are formed by the germination of spores that have been carried, on the fruit, from the orchard into the car.

Breaks in the skin, due to bruises, insect injury, etc. favor such transit infection but are not necessary to it; the fungus is able to penetrate the uninjured skin of the peach.

The majority of refrigerator cars rarely show a temperature below 42 degrees F. when they arrive on the market. It is clear, therefore, that under present shipping conditions there is practically always danger of brown rot developing or spreading in transit if it was present in the orchard.

In the orchard brown rot can be controlled by spraying with self-boiled lime-sulphur for the fungus, and with arsenate of lead for curculio which distributes the spores. In storage and transit the disease can be controlled by keeping the temperature somewhere between 45 and 50 degrees F. If the temperature goes above 45 degrees F. there is danger of loss.

PEACH: CURCULIO INJURY.

Cause: An insect (Conotrachelus nenuphar).

Curculio injury is of two kinds depending upon whether it is caused by the adult insect or by the larva. In the first case the injury is confined to the outside of the peach, that is, to the skin and the flesh just beneath it; in the second it extends deep into the flesh, usually clear to the pit.

Injury by the adult insect may be due to egg-laying punctures or to feeding punctures. In either case there is a break in the skin, more or less of cork formation and usually an extrusion of masses of gum. Egg-laying punctures are crescent shaped when made but generally lose this shape as the peach grows.

Injury by the larva consists of tunnellings through the flesh and a more or less complete disorganization around the pit. The larva itself, a white worm one-eighth to three-eighths of an inch long depending upon its age, is often found.

Curculio injury is often followed by brown rot, because of accidental inoculation of feeding punctures or egg-laying punctures with spores borne on the insect's body or by the wind.

Curculic can be controlled by spraying with arsenate of lead.

PEACH HAIL INJURY.

PEACH: HAIL INJURY.

Hail injury on this fruit consists of irregular, ragged-looking, more or less sunken spots. They differ from curculio injury in being larger, in showing little or no gummy exudate and no trace of larval burrows underneath. Injury by fruit beetles is sometimes mistaken for hail injury or curculio but can be distinguished from either by the smooth layer of wound cork which covers the spots. Damage by birds or grasshoppers occurs late in the season, hence has little chance to heal over before the fruit gets to market.

PEACH (WHISKERS)RHIZOPUS ROT.

PEACH: RHIZOPUS ROT.

(See Strawberry: Rhizopus rot).

PEACH SCAB

PEACH: SCAB.

Cause: A fungus (Cladosporium carpophilum).

Scab usually occurs on the upper part of the fruit, as small, circular olive-black spots affecting only the skin and a shallow layer of the flesh beneath. In cases of severe infection the spots ccalesce to form large dark sooty areas and the fruit becomes dwarfed or mis-shapen, due to the formation of a protective layer of cork under the diseased area. Cracks may be formed by the breaking of this protective layer, and a way opened for infection by the brown rot fungus, Rhizopus or blue mold. In dry seasons the disease is very light, occurring in the form of separate spots which blemish the fruit but do not greatly affect its market value. In wet seasons it may become so serious, due to coalescence of the spots and subsequent cracking, that the whole crop is unmarketable.

The disease attacks not only the peach but also the apricot and nectarine.

The characteristics of scab are so well marked that there should be no difficulty in distinguishing it from all other diseases of the peach.

Scab occurs in all portions of the United States east of the Rocky Mountains and also in California. Of the commercial varieties Heath and Salway seem to be the most susceptible.

Elberta, Carman, Hiley Belle and Champion are affected, but usually only to a slight extent.

Of the diseases of the fruit of the peach, scab is second only to brown rot in economic importance. In some seasons the loss for certain sections has been estimated at ten per cent of the crop, while for the whole United States the total annual loss has been placed at $1,000,000.

Scab is strictly a field disease and does not develop or spread in transit or storage. It can be controlled by spraying with self-boiled lime sulphur.

PEAR PINK MOLD ROT FOLLOWING SCAB.

PEAR AND APPLE: PINK MOLD ROT.

Cause: A fungus (Cephalothecium roseum).

Pink mold rot is the result of secondary infection by the fungus Cephalothecium following some other injury, commonly scab; primary infection directly through the uninjured skin is not known to occur. The disease occurs in two rather well marked stages, with various transition stages in between. In the first of these the rot appears as definitely sunken, brown areas about one-eighth of an inch wide encircling scab spots. At such places there is usually a growth of white mycelium or, under warm, moist conditions, a pink-colored mass made up of mycelium and the spores of the fungus.

If conditions favor the continued growth of the fungus, the second or final stage of the rot soon follows. This is characterized by light, chocolate brown, sunken areas of irregular outlines varying in diameter from one-half inch to two inches or more; over the surface of these areas are scattered, circular spots somewhat depressed below the general level of the rot, whose color is markedly lighter brown than that of the rotten area surrounding them. This stage of the rot is less likely to show the white to gray mycelium or pink spore masses than the first stage. In any stage of the disease the rotted areas are rather firm and dry, or at least not watery.

Pink mold rot can be distinguished from blue mold rot by the fact that tissues affected by it are brown, firm and rather dry, not pale brown and soft and watery. The two are also readily distinguished by the color of the spore masses when these are produced. Pink mold rot differs from black rot in showing the small, circular, very light brown, sunken spots already mentioned, scattered over the surface of the general rotted area, and by the absence of pycnidia (spore bearing bodies). The rotted tissues usually have a marked bitter taste.

The disease was formerly more prevalent and destructive than it is at present, because of the custom, now practically discontinued, of piling apples and allowing them to sweat. However, it is

still common on Baldwin and Rhode Island Greening in storage and sometimes occurs on fruit still hanging on the tree. It is found also on Pound Sweet, Maiden Blush, Yellow Transparent, Twenty Ounce Pippin, Fall Pippin and Golden Russet. In the case of the latter variety it follows injury by a physiological spot similar to Jonathan spot.

The rot develops in transit and storage, especially on poor scabby stock, but more slowly with refrigeration than without. Because of the manner of infection it is not likely to spread in transit or storage unless the fruit is held for some time without refrigeration.

The disease is most common in the northeastern apple growing sections, especially in New York, Ohio and Michigan but has been found in Nebraska and the Wenatchee region in Washington.

The rot can generally be controlled by controlling scab, and by storing fruit as soon as possible after harvesting, in dry, well ventilated rcoms at a temperature of about 32 degrees F.

PEAR BLACK SPOT.

PEAR: BLACK ROT.

(See Apple: Black rot).

PEAR - BLACK SPOT

PEAR: BLACK SPOT.

(See Quince: Black spot).

PEAR RHIZOPUS ROT.

PEAR: RHIZOPUS ROT.

(See Strawberry: Rhizopus Rot).

PEAR SCAB.

PEAR: SCAB.

Cause: A fungus (Venturia pyrina).

Scab on pears is similar to the disease of the same name on apples. The two are caused by different species of the same fungus. If there are any differences between them it will be found in the fact that pear scab usually occurs as larger rougher spots than are common for apple scab. On Seckles and possibly on other varieties very small scab spots sometimes occur that may be mistaken for other blemishes, if not carefully examined.

Pear scab is most common and most destructive in the northern parts of the United States east of the Mississippi River. It can be controlled by the treatment recommended for apple scab.

PEAR SOOTY BLOTCH.

PEAR: SOOTY BLOTCH.

(See Apple: Sooty blotch).

PINEAPPLE BLACK ROT

PINEAPPLE: BLACK ROT.

Cause: A fungus (Thielaviopsis paradoxa).

The chief characteristics of this disease are a soft water soaked condition of the affected tissues, a marked sour odor due to fermentation of sugars and a blackening of the deeper lying regions penetrated by the fungus. Badly affected specimens, so softened they can be pulled apart by the hand, ordinarily show all of the fruit blackened except about the outer half inch.

Two types of the rot can be distinguished, depending upon whether infection takes place at the butt or on the side. If at the butt the fungus grows rapidly in the water-conducting tissues at the center of the fruit, producing very early all of the symptoms described above. So rapid is the development of this type of the disease that fruits which show only a slight loosening of the cut stem may be rotten and black clear to the other end. If infection takes place at the side, rotting progresses much more slowly. The lesion produced here is cone-shaped, with the small end toward the center of the fruit. Blackening may or may not occur depending upon the size of the lesion, but there is always a softening of the tissues and an odor of fermentation.

Black rot is a field disease but is not usually serious there. Under favorable conditions of moisture and temperature the fungus causing it is able to decay perfectly sound uninjured fruit in either the green or the ripe state. In such cases it probably enters the fruit through the crevices between the eyes. In fruit ready to be shipped or on the way to market it also enters through the cut stem and through breaks in the skin due to bruises or other injuries.

Black rot can be distinguished from all other pineapple rots by the extensive softening and blackening of the tissues and by the marked sour odor.

Losses from this disease are probably due to several factors, among which are the succulent, perishable nature of the pineapple, the careless handling to which it is subjected during the picking and packing processes and the long haul - at

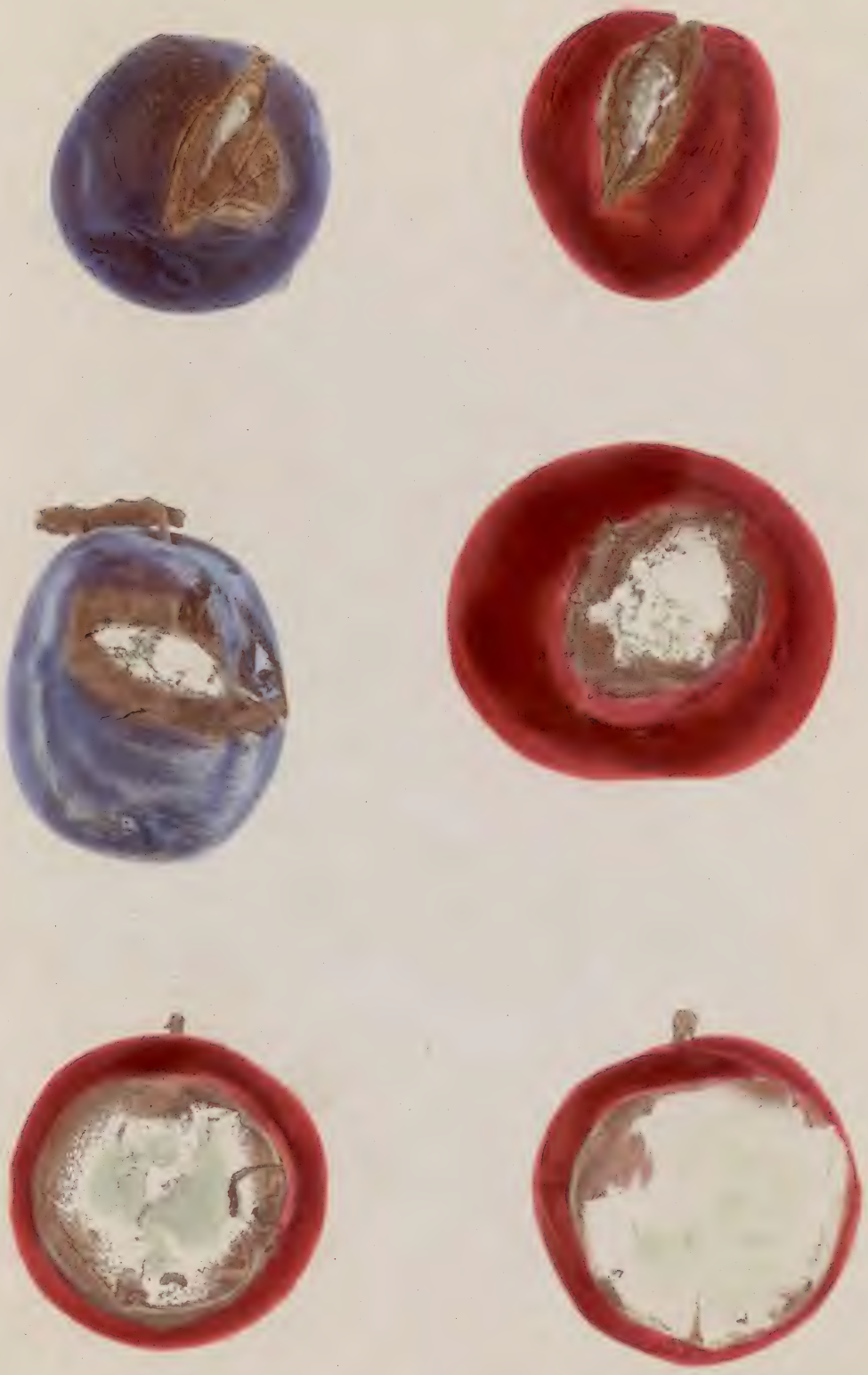
least seven to ten days - from producing sections in Cuba and Porto Rico to northern markets. The practice of shipping pineapples from Havana to Key West by freight-car ferry in poorly ventilated loads of 400 to 1100 crates undoubtedly does much to increase loss from this disease. A few cars inspected in Chicago during the winter and spring of 1919 showed 40, 50, even 75 per cent of the fruit affected by black rot while the average for all shipments was 8 to 10 per cent. It is estimated that the loss due to black rot in pineapples from Porto Rico during the shipping season amounted to over 10 per cent of the total shipments.

It is hardly necessary to say that the disease develops rapidly in storage and transit. Overloading seems at times to favor its development but cars carrying the ordinary load of 300 crates (from Key West) often show a high percentage of rotten fruit. Whether it spreads in transit or storage from diseased to healthy fruit is a question for further investigation.

All of the varieties shipped are susceptible to the disease. The greatest losses occur in the case of Spanish Red but merely because this variety makes up the great bulk of all shipments. The Smooth Cayenne and Cabezano varieties rot badly, and probably for this reason are rarely seen on the market.

Fruits infected from the butt end are usually so badly rotted as to be unfit for food, and hence are thrown away; those infected from the side are still usable and are often sold to fruit stores and canneries as "spots".

Little is known of methods of control. Preliminary tests indicate that much of the loss from black rot can be prevented by shipping pineapples under refrigeration.



PLUM BLUE MOLD ROT

PLUM: BLUE MOLD ROT.

(See Orange: Blue mold rot).

PLUM BROWN ROT AND RHIZOPUS ROT

PLUM: BROWN ROT AND RHIZOPUS ROT.

(See Peach: Brown rot and Strawberry, Rhizopus rot).

PLUM RHIZOPUS ROT.

PLUM: RHIZOPUS ROT.

(See Strawberry: Rhizopus rot).

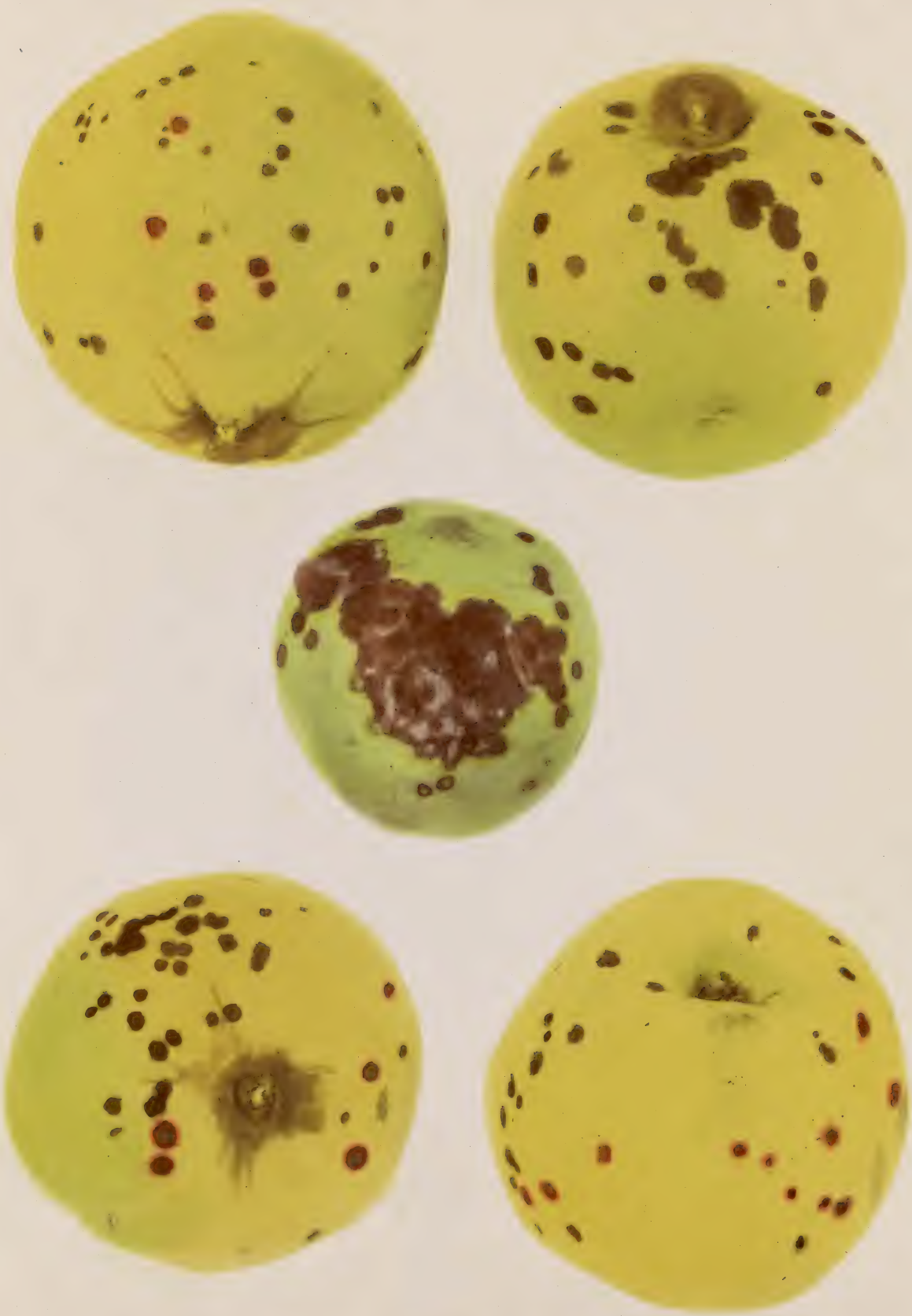
PLUM RUSSET.

PLUM: RUSSET.

Cause: In doubt.

The signs of this disease are irregular, rough russeted spots anywhere on the surface of the fruit. Nothing is known definitely as to the cause of them. They are thought to be due to the combined action of aphids, a surface growing fungus and weather conditions, possibly frost.

Russet is of importance merely as a blemish.



QUINCE BLACK SPOT

QUINCE: BLACK SPOT.

Cause: A fungus (Fabraea maculta).

This disease appears as black, circular, slightly sunken spots which are usually surrounded by a red ring. The spots may occur on any part of the fruit. They vary in diameter from 1/16 to 3/8 of an inch.

The disease does not develop or spread in storage or transit and is not commonly followed by rot of any kind. It occurs on both pears and quinces and is most common in regions east of the Mississippi River. It has not been seen on fruit from California or the Northwest.

BLACK RASPBERRY RHIZOPUS ROT.

BLACK RASPBERRY: RHIZOPUS ROT.

(See Strawberry: Rhizopus rot).

STRAWBERRY GRAY MOLD.

STRAWBERRY: GRAY MOLD ROT.

(See Grape: Gray mold rot).

STRAWBERRY RHIZOPUS ROT.

STRAWBERRY: RHIZOPUS ROT; LEAK.

Cause: A fungus (Rhizopus nigricans).

This fungus, sometimes known as Whiskers, produces at ordinary temperatures a growth of long, rather coarse, white threads (mycelium) which at times envelops the affected fruit. The mycelium bears small, spherical fruiting bodies which are white and glistening at first and later become black and dull. At low temperatures - 40 to 45 degrees F. - very little mycelium is produced and the sporangia grow in dense masses close against the fruit. The sporangia contain the spores. When they open the spores are easily distributed by air currents or by the hands of workmen sorting the fruit. Fruit badly rotted by Rhizopus usually has a marked sour smell. Infection by Rhizopus is usually confined to fruits, the skin of which has been broken by mechanical injury; in peaches Rhizopus is often found on fruits that show no injury. In such cases the assumption must be that the fungus penetrated the uninjured skin.

This rot on peaches, in many cases clearly due to primary infection by Rhizopus, bears some resemblance to brown rot. It differs from brown rot, however, in showing a somewhat lighter brown color of the rotted tissues and by the time the peach is half decayed a soft condition of the flesh. At this stage the characteristic mycelium and fruiting bodies usually appear, which are easily distinguished from the grayish spore-bearing tufts of the brown-rot fungus. A further distinction between the two rots is that in Rhizopus rot the skin slips readily from the diseased flesh but clings tightly to it in brown rot.

In berries and grapes Rhizopus causes a watery rot known to the trade as leak. The name originated from the fact that when the fungus attacks the fruit it breaks down the tissues and liberates the juice.

The fungus is practically always present in the field and in cars but since it grows best at 50 degrees F. or above, it is not likely to cause much rotting if shipments are properly iced and the temperature kept at 40 to 46 degrees F. If the fruit shows mechanical injury and the tempera-

ture rises much above 40 degrees F. there is danger that loss will result.

Obviously, control of the rot depends upon proper refrigeration and the avoidance of mechanical injury.

STRAWBERRY SCLEROTINIA ROT

STRAWBERRY: SCLEROTINIA ROT.

Cause: A fungus (Sclerotinia libertiana).

Strawberries affected with this disease are firm but rather watery and usually show small amounts of a white, cottony, fungus growth. If they are held in a close moist place this growth becomes quite luxuriant. If held in a dry place the berry shrivels, the fungus growth collapses and finally forms hard, black masses known as sclerotia or resting bodies.

The disease occurs in the field, in various producing sections of the south, but is not often seen on the market. It was noted in rather large amounts in one car inspected in Chicago during the spring of 1920. Losses caused by it are probably not large.

No studies have been made on methods of control but the known ability of the fungus to grow under refrigeration conditions would indicate the field as the place to begin.

dustry.
ses of fruits occuring
and transit conditions.